Deals and Development

LNG and Climate: Prices and Pacing

Thomas C. Heller

Program on Energy & Sustainable Development

Stanford University

http://pesd.stanford.edu/

Five Myths

1. Climate Change isn't a problem
2. Fossil Fuels will Run Out Shortly
3. The "Engineers' Myth"
4. The "Planners' Myth"
5. The "Diplomats' Myth"
    - Policy Planning can be extended to the global level
    - All countries should be involved in the most effective solutions
    - Enforcement is based on sovereign state model

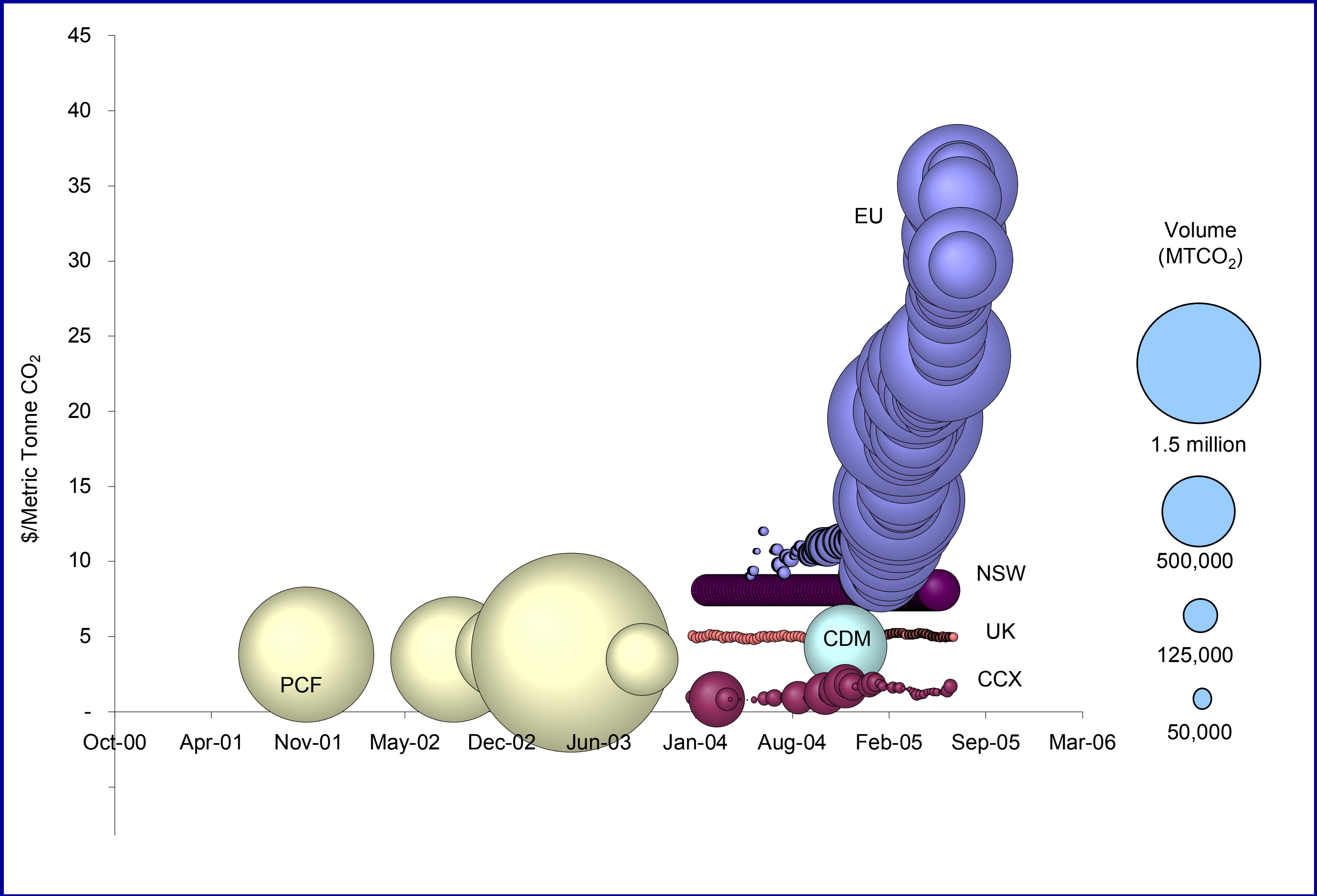
Kyoto: Climate Change Strategy

	Industrialized Countries	Emerging Markets	Least Developed Countries
Energy Efficiency	Low price Signal	Trading; Graduation	Trading; ODA
Fuel Switching	Increasing Price Signal	Trading; Graduation	Trading; ODA
Innovation	+ Increasing(?) Price Signal	Technology Transfer; Graduation	?

Beyond Kyoto

- Few OECD nations assume positive costs
- Developing nations refuse mitigation commitments
- Politically acceptable price signals too low for fuel switching or commercialization of new technologies
- Global markets weakly regulated (gamed)
- Only a few countries emit most GHGs
- Wrong people at the diplomatic table

A Madisonian Perspective: Emerging Carbon Currencies



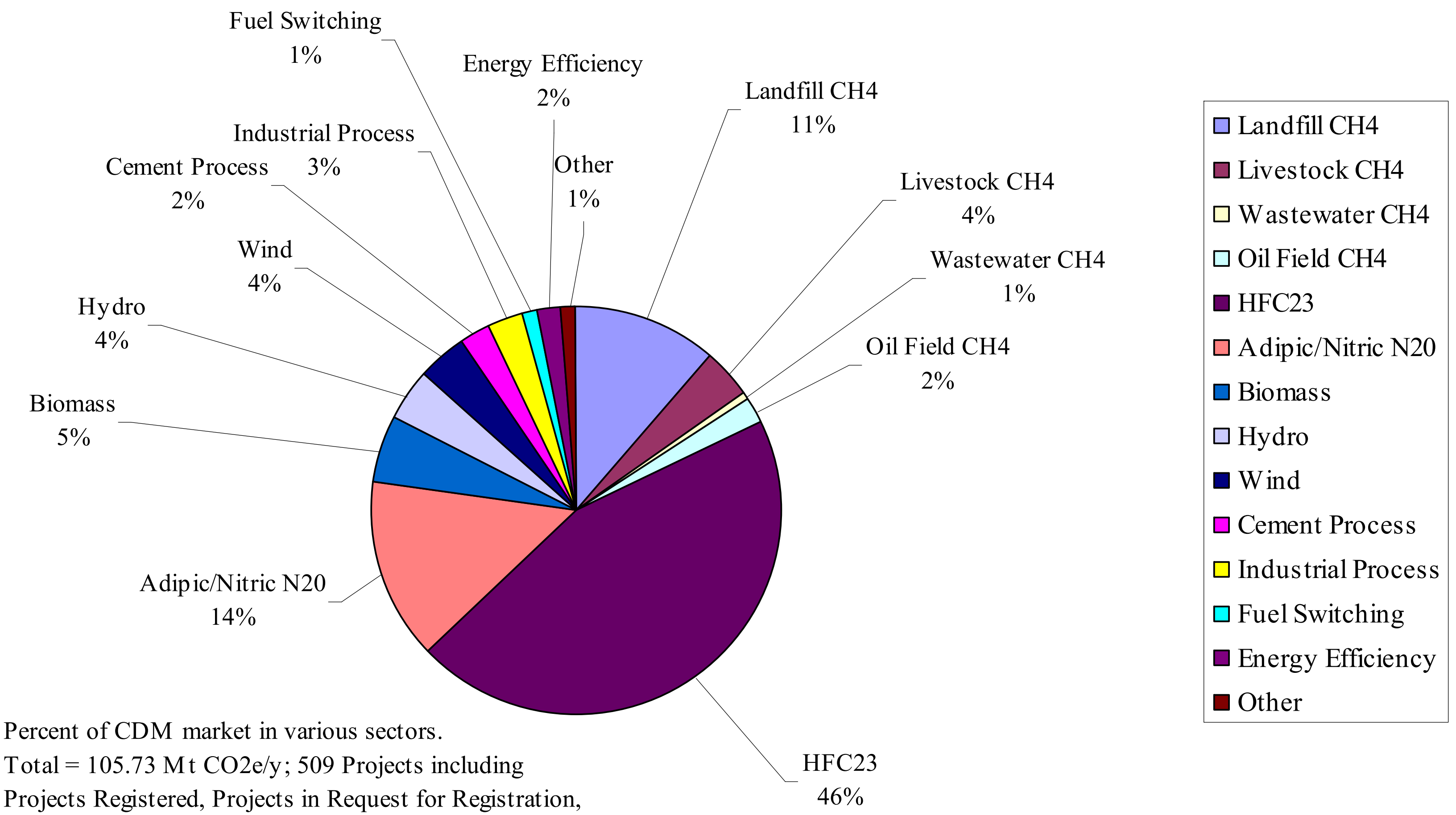
Sources: PointCarbon, International Emissions Trading Association

Reprinted from Victor, House & Joy (2005)

Limitations of the CDM Model

- **Tropical "hot air": currency devaluation**
  - CH_4: land fill and flaring
    - Rising natural gas prices
    - Local environmental controls
  - HFC23: industrial processes gases
  - Renewable Portfolio standards withdrawal
- **High transaction costs**
  - Small Scale Projects
  - No methodologies for large-scale energy efficiency and fuel switching
- **Baseline identification**
  - Baselines feasible <u>only</u> for marginal activities

CDM Market by Sector



Percent of CDM market in various sectors.
Total = 105.73 Mt CO2e/y; 509 Projects including Projects Registered, Projects in Request for Registration, Post-Validation, or Validation Stage by CDM Board as of 23.12.05

CDM mistakes

- No actual reductions beyond market behavior
- Inefficient subsidies
- Displace legal controls
- Displace voluntary agreements
- Existing production expanded to increase baseline
- New production registration will increase leakage

Beyond Kyoto

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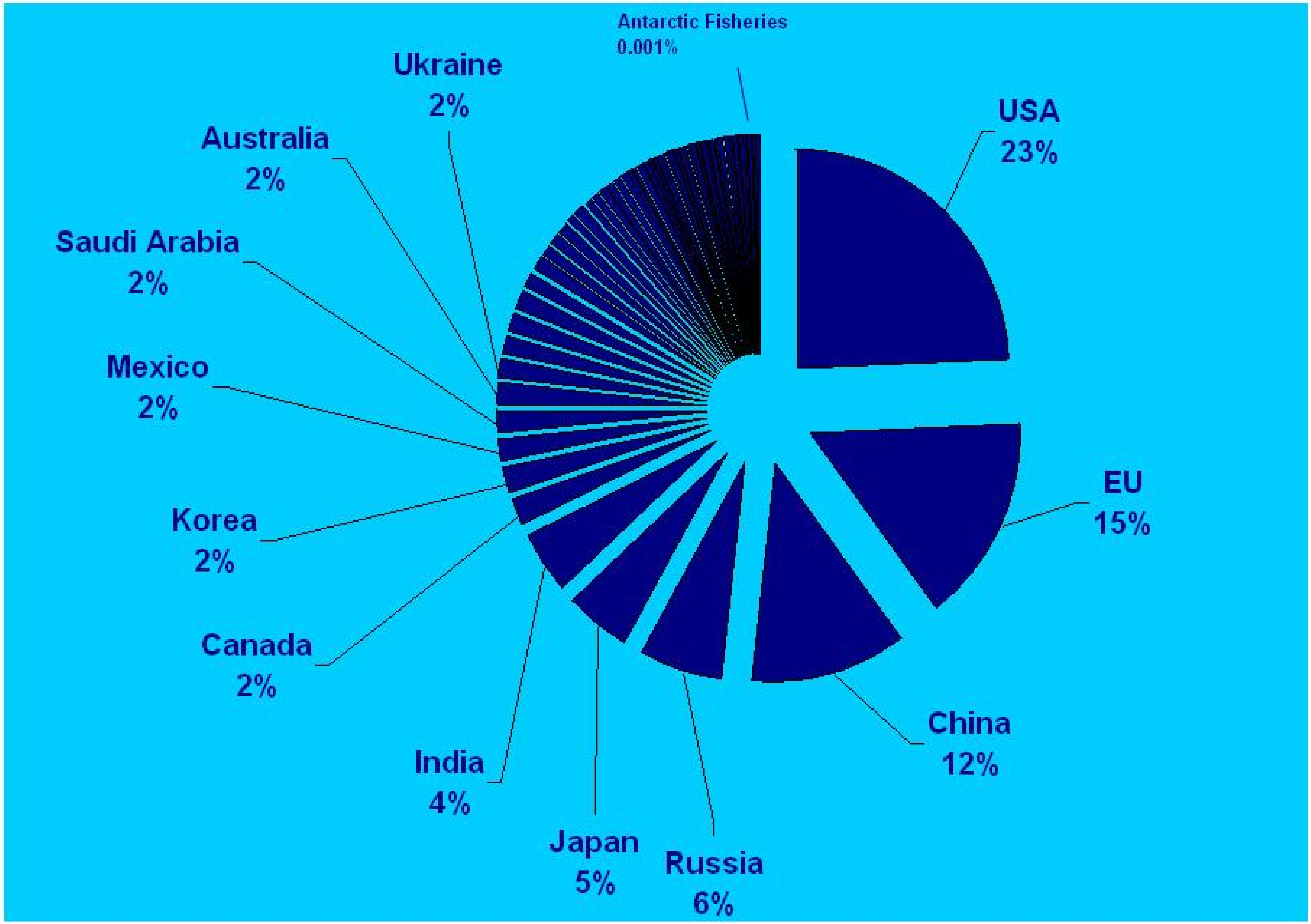
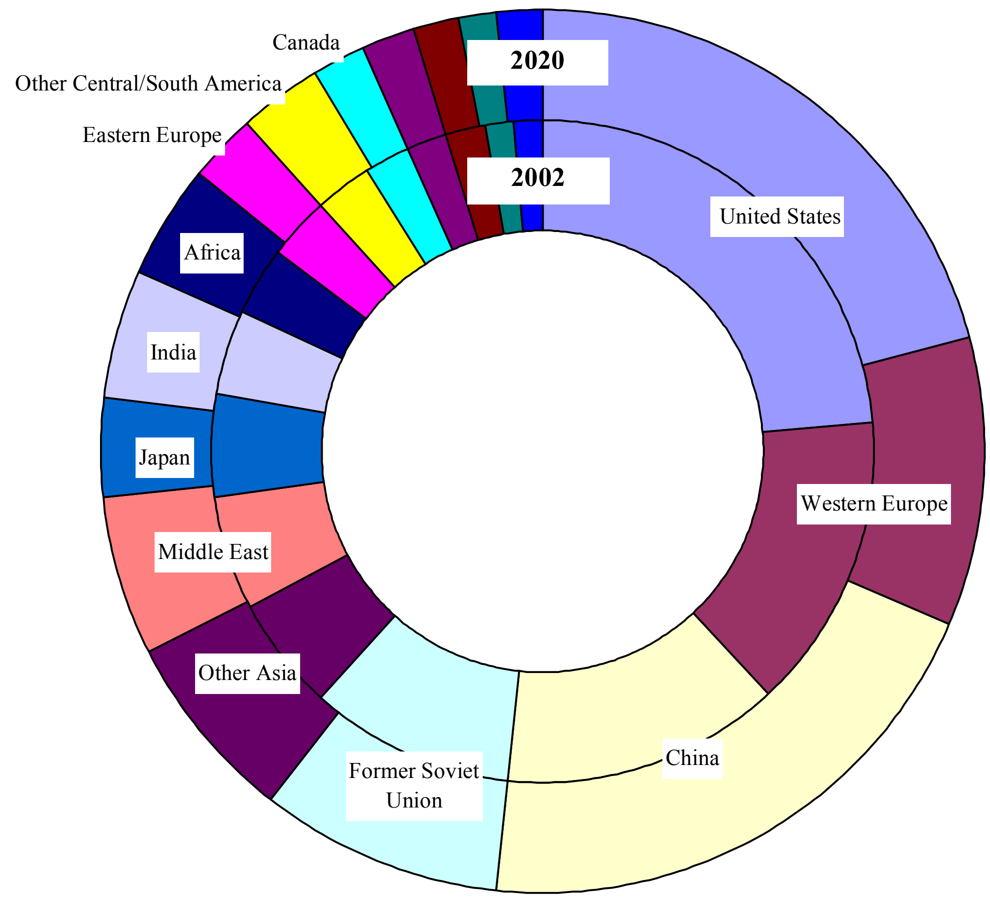
- Wrong people at the diplomatic table

Allocation of World Emissions: Only a Few Countries Really Matter



World CO_2 Emissions by Region



Source: EIA

Building Blocks: International Regimes

- Multiple clubs with members sharing local cooperative solutions are more likely to support international regime growth than comprehensive multilateral arrangements
  - The more closely agreements are built around non-cooperative solutions, the more likely they will be implemented
  - Most international environmental regimes in the past half century have less than 7 members
  - Trading across fragmented international regimes is limited, reducing the value of wide and diverse membership in each regime

Beyond Kyoto

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- Developing nations refuse mitigation commitments
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- Only a few countries emit most GHGs
- Wrong people at the diplomatic table (PE)

Building Blocks: Sectors

- Climate mitigation is a derivative problem of three economic sectors central to growth and development
  - Energy
  - Transportation
  - Land Use

Building Blocks: Sectors

- Government actors from these sectors make decisions on the development paths their economies will follow
  - Line ministries
  - Finance ministries
- Political priorities of these actors are nowhere focused on climate, especially in developing countries
  - Environmental constraints on emitting sectors are resisted unless they advance higher priority goals
- Actors from key emitting sectors are rarely represented in climate negotiations

Logic of Social Change

- Normative result
  - Global or national
- Barriers
- Political Will
- State led
- Policy shocks?
- Break up global problems to manageable scales in which actors are enabled, and political economic incentives are aligned

Background Shifts: IEA 2006

- Oil price remains high
- Return to coal
- Re-carbonization of earlier declining trend to de-carbonization
- China overtakes US in CO_2 emissions by 2010
- Energy security emerges as core issue
- *Energy intensity increases in developing countries understated by IEA*

A Simplified Story Line (1)

- Power dominates transport given current fuel prices and technology development
  - Fleet turnover time is determinative
- A low level carbon tax (equivalent) is a non-cooperative climate solution among OECD countries
- Energy efficiency gains are non-cooperative solutions among emerging economies
  - If substantial, policy needed is information rather than international coordination or targets (IRP and DSM)
  - Issues shift from economic to political economic

A Simplified Story line (2)

- Emerging economies have potential for fuel switching in well-diffused commercial power technologies
- Speeding the commercial diffusion of new technologies in power generation and distribution is the ultimate key to climate mitigation
- Policies to affect fuel switching and technology innovation are likely to be more indirect and downstream than direct and upstream
  - Political economy and organization theory are keys

Building Blocks: Problems

- Climate change mitigation can be broken down into three separate problems
  - The immediate need for a low level carbon price signal
    - Incentives to look for mitigation opportunities that save costs and carbon (no regrets pools)
    - Incentives to adopt options to mitigate carbon whose incremental costs are only marginal (below price signal)
  - The mid-term need to diffuse more rapidly than business as usual existing commercial technologies that are relatively less climate damaging
    - Cooperative measures to engage leading developing countries with rapidly growing carbon emissions
  - The long-term need to develop energy, transport and land use technologies that are currently across the commercial horizon

Potential CO2 emission reductions: IEA2006

Technology	2015	2030	2050	GT CO2/ year
NGCC	++	+++	++++	1.6
Advanced Steam cycle (coal)	+	++	++	0.2
IGCC (coal)		+	++	0.2
With CCS		++	++++	1.3
Wind	++	+++	++++	1.3

NGCC: midterm: IEA 2006

- Mature technology
  - F class turbines since 1990s
  - Average efficiency (LHV) 42%; new 60%
- Capital costs below coal
  - US$450-600; typical coal US$1000-1200
- CO2 less than half of coal fired plants
  - varies with vintage
- Fuel costs 60-85% total generation costs
- Peaking capacity & Modularity
- Pipe fixed contract and LNG contractual structure
- Power as a regulated industry and organizational capacity

Post-Kyoto: Climate Strategy

	Industrialized Countries (***Positive CO2 Price***)	Emerging Markets ***(Residual inefficiency)***	Least Developed Countries
Energy Efficiency	Low price Signal; Kyoto + +	Deals: Implementation ***(Short-term)***	ODA
Fuel Switching	Market Development with Program Subsidies	Deals: Market development ***(Mid-term)***	ODA
Innovation	Technology Policy Strategies	Deals: Diffusion Pace ***(Long term)***	?

Building Blocks: Pillars

- Each separate climate problem is best approached through separate institutional pillars that are tailored to the specific problem
- The climate regime should be composed of multiple pillars differentiated from one another according to:
  - The nations involved
  - The actors from each nation with policy authority
  - The timelines demanded
  - The instruments and measures to be used
- The Kyoto Protocol, particularly tailored to low level price signals, should be maintained in the UNFCCC framework, but should also be supplemented by new pillars tailored to the diffusion and technology development problems

Deals as international relations

- Small numbers game
  - Deals easier to monitor against gaming than general markets
  - Not general rules and regulatory capacities but specific arrangements
- Baselines negotiated in the package
  - Baselines in transition or developing countries in flux
  - Endogenous to incentives
- Actors with actual involvement in sector
- Non-cooperative solutions
  - Stay close to policy choices in play domestically among authorized agencies and engaged firms

Elements for a Deal

- **Policy package at national level**
  - Energy policy changes
  - Complementary to market reforms
- **Organizations capable of financial and technical risk bearing**
  - Market development
  - May be related to upstream asset sales
- **Contextual changes**
  - Often indirect changes in security or trade system
- **International cooperative mechanisms**

Indirect focal points for deals

- Asia-Pacific natural gas markets
  - Regional commodity market stabilization
    - Supply security
  - Decentralization of energy policy
  - Financial reform
- Amazonia deforestation
  - Land use and national security
- Advanced nuclear generation
  - Fuel cycle control (proliferation)
- Hydropower in Southern Africa
  - Physical security
  - Infrastructure finance risks

Deals

- Shift Business as Usual
  - Alternative development paths
  - Often industry led technology shifts
- Close to policies in play in agencies with decision authority
  - Development priorities recognized
- Shift policies, infrastructure, context
  - Not project specific, additional
  - Subsidies, domestic benefits, carbon markets
- Often may be indirect climate effects (context)
  - Not necessarily focused on energy policies
- UNFCCC compatible; IFI/Ex-Im supportable

A natural experiment?

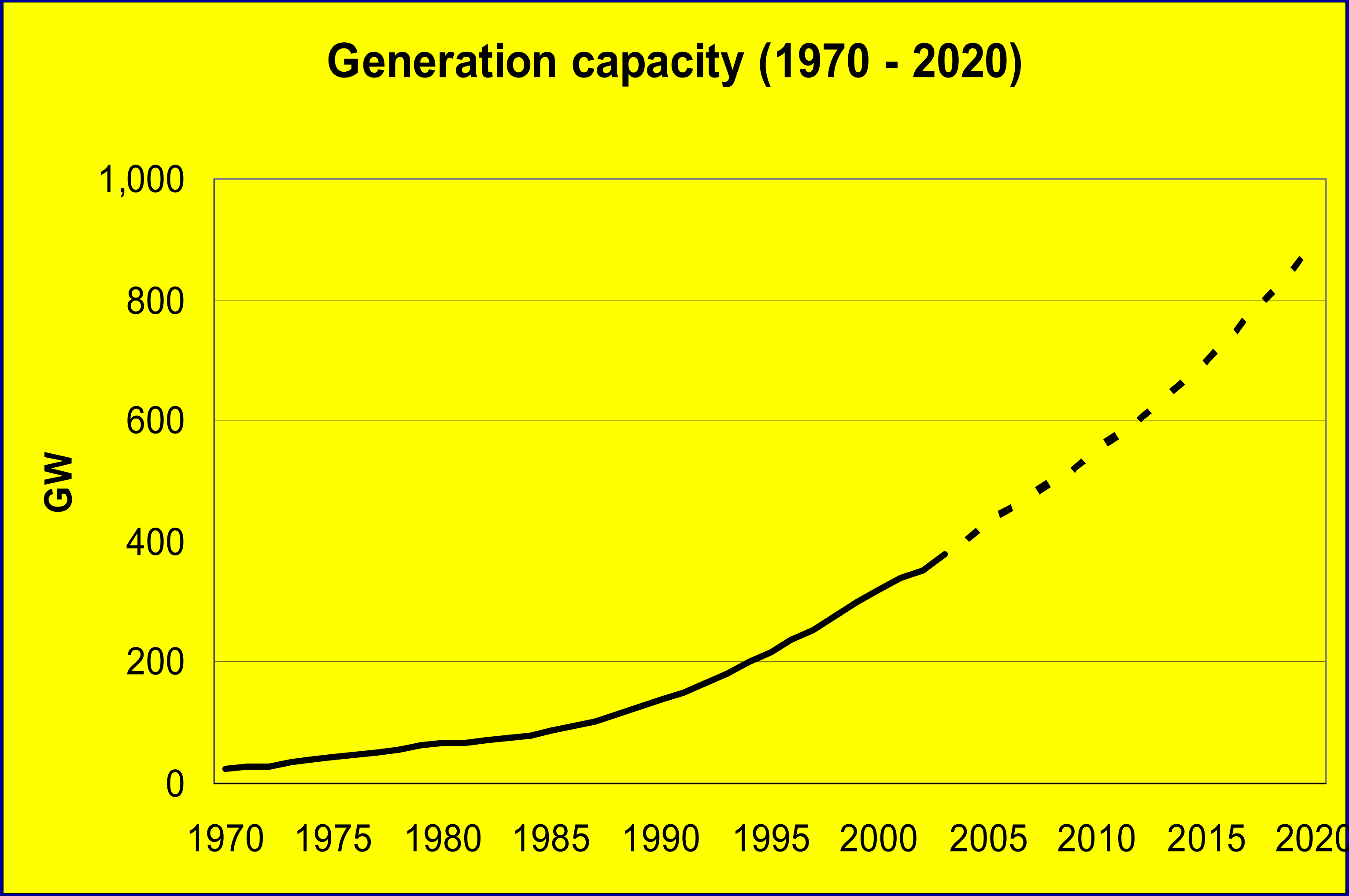
- The rise in oil and gas prices is equivalent to a carbon tax in those sectors of more than $100tonne/CO2
- EIA and IEA energy outlooks for 2020/30 both indicate low reductions in emissions below earlier baselines with lower oil and gas prices, even with prices stable at these levels
- Increased reliance on nuclear, wind power, conservation and demand declines are importantly offset by increased reliance on coal
- Policy options to alter these outlooks include a general carbon tax in addition to the price rises or shifting gas-coal price formation mechanisms to reduce the offset effects
- The issue is which policy option is more politically feasible in connection with key emerging economies

Primary Energy Consumption

Country	Million Tonnes Oil Equivalent[1] 1980	1990	2004	% Change 1980-2004	1990-2004
U.S.	1,813.2	1,966.2	2,331.6	28.6%	18.6%
China	426.9	685.8	1,386.2	224.7%	102.1%
India	102.9	193.4	375.8	265.2%	94.3%

[1] Source: BP Statistical Review of World Energy June 2005, on-line: http://www.bp.com/statisticalreview

Overview - capacity



Overview -- 2004 Boom

	2004	2003	Growth %	Structure %
Installed capacity (GW)	441	391	13	100
Hydro	108	95	14	25
Thermal	325	290	12	74
Nuclear	7	6	11	2
Generation (TWh)	2187	1905	15	100
Hydro	328	281	17	15
Thermal	1807	1579	15	83
Nuclear	50	44	14	2
Operating hours	5460	5245	4	
Hydro	3374	3239	4	
Thermal	5988	5767	4	
Consumption (TWh)	2174	1892	15	100
Agriculture	61	60	3	3
Industries	1626	1396	16	75
Services	244	211	15	11
Residential	243	225	8	11
Urban	147	136	8	7
Rural	96	88	9	4

Chinese total energy consumption: IEA

2000		2030	
– Coal	69%	– Coal	60%
– Oil *	25%	– Oil*	27%
– Gas	3%	– Gas	7%
– Nucl./hydro	2%	– Nucl./hydro	6%

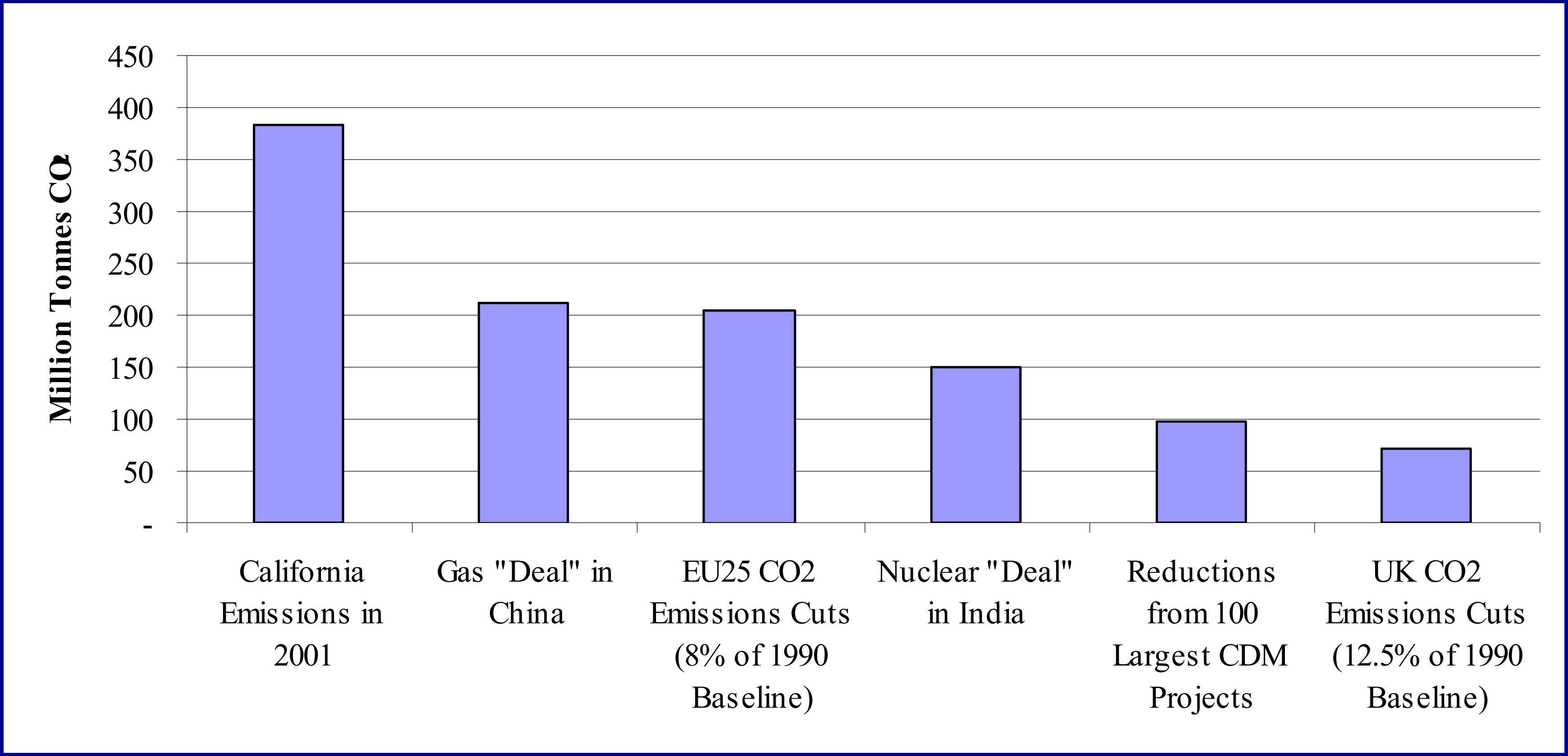
*imports 37%

Imports 63-70%

Thought experiment: Gas Deal in China

- Best estimates new generation capacity at least 50 GW in 2004 and 60-70 GW in 2005
  - Rising production of 14.9% between 2004 and 2005
  - Energy intensity exceeds 1.0; electricity 1.4
- June 2006, total installed capacity was 531 GW
  - More than 70 GW of newly installed capacity to be placed in service this year
    - New capacity more than 80% coal fired
    - Approximately 250GW in new power station projects under construction
    - Approximately 25% planned new capacity supercritical coal
- <u>*Imagine China replaces 50 GW of planned coal capacity with natural gas (baseload CCGT) by 2020*</u>
  - <u>*15% reduction over IEA's baseline for coal capacity in 2020*</u>

CO_2 Savings in Perspective



China Reference Scenario

	Installed Capacity (GW)[1]	
	2002	2020
Coal	247	560
Gas	8	67
Total Capacity[2]	360	855

[1] Source: World Energy Outlook 2004

[2] Total capacity includes coal, gas, oil, nuclear, hydro, and renewables.

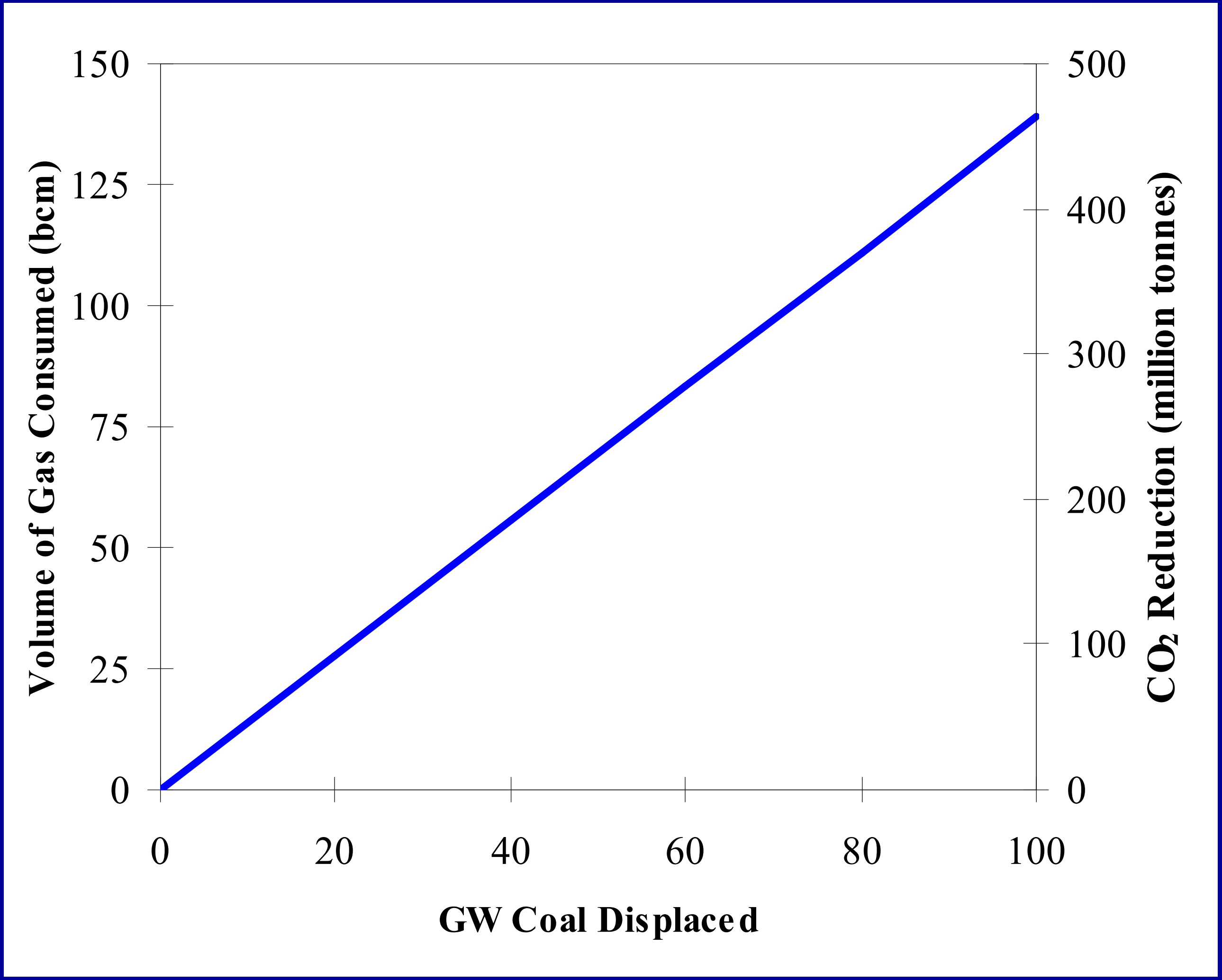
China Deal: Load Factor and Carbon Intensity Assumptions

	Subcritical Coal	CCGT
Load Factors	0.85	0.90
Emissions rate (tonne CO_2/GWh)	920	350

China Deal: CO2 Savings

	Coal Scenario	Gas Scenario
Capacity (GW)	50	47
Total Generation (TWh)	372	372
CO_2 Emissions (million tonnes CO_2/year)	343	130
GHG Reductions (million tonnes CO_2/year)	***213***	

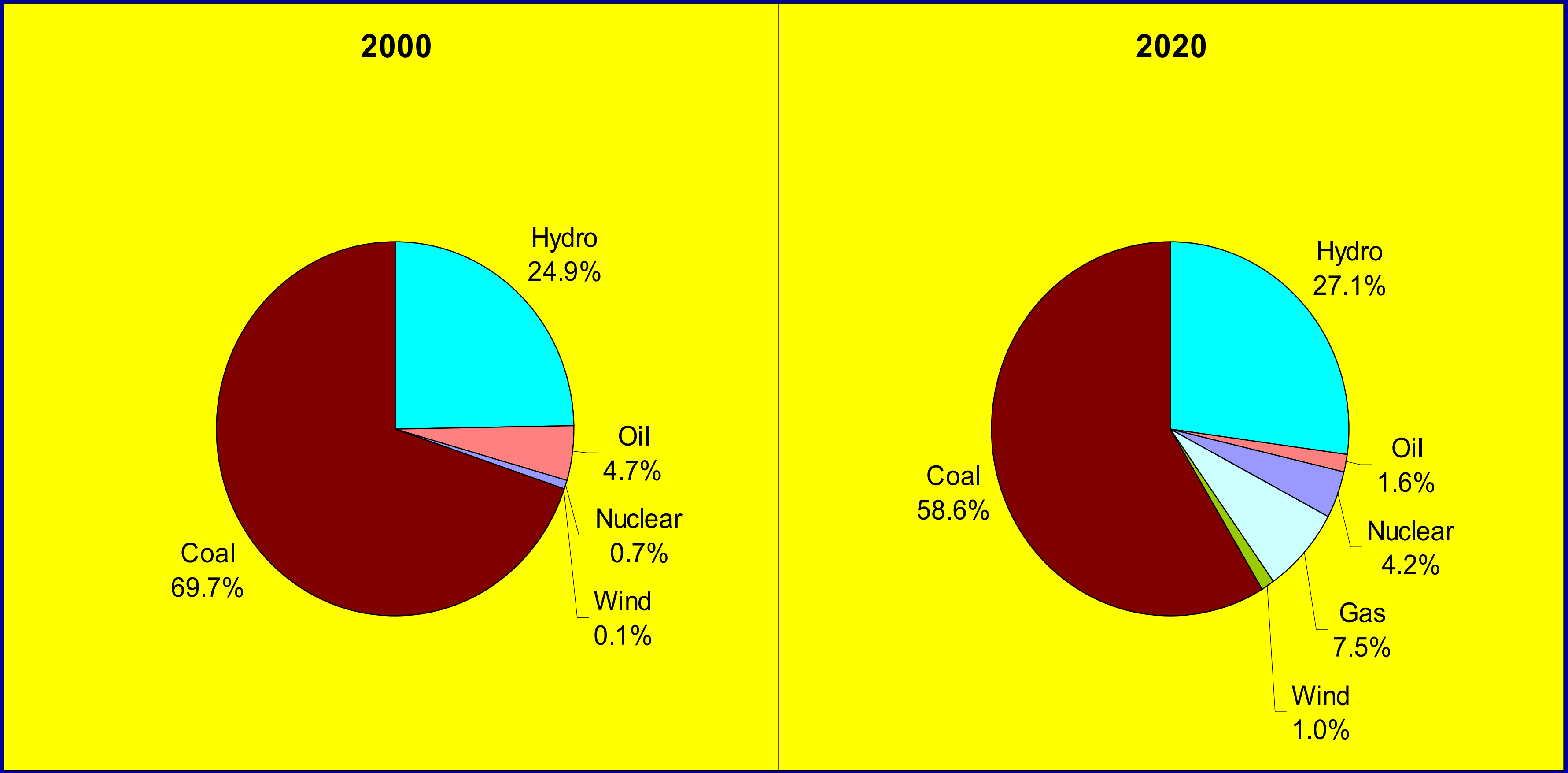
China Deal: 2020 Implications of Coal Displacement



Central Government Plan to 2020

- Real GDP grows 7-8% per year; GDP p.c. reaches $10,000 (PPP basis)
- Primary energy consumption grows 4.5-5% per year
- 520 GW (30 GW per year) generation capacity will be added
- Natural gas to provide new and clean sources of energy
  - Over 7% annual growth rate
  - Consumption to increase from 40 bcm to between 140 and 200 bcm under various policy scenarios

Overview – fuel structure



Central Government Plan

- Demand Uncertainty
  - Domestic (Chinese) gas forecast driven by higher price for gas than coal, driven by
  - Higher gas costs
    - Security requirement – 2/3 domestic production, 1/3 imports
    - Domestic production costs
    - Infrastructure development costs

China’s gas power development

- First 2 plants come on line in June 2005
  - Gas transported from Tarim Basin by E-W pipeline
- 18.4 GW under construction
- Plan is for total of 60 GW in 2020
  - 6% national electricity capacity
- 2 re-gasification terminals to open to 2006-07 in Guangdong and Fujian
- 15 LNG re-gasification terminals announced by Chinese national oil companies
  - 9 terminals reported approved by NDRC

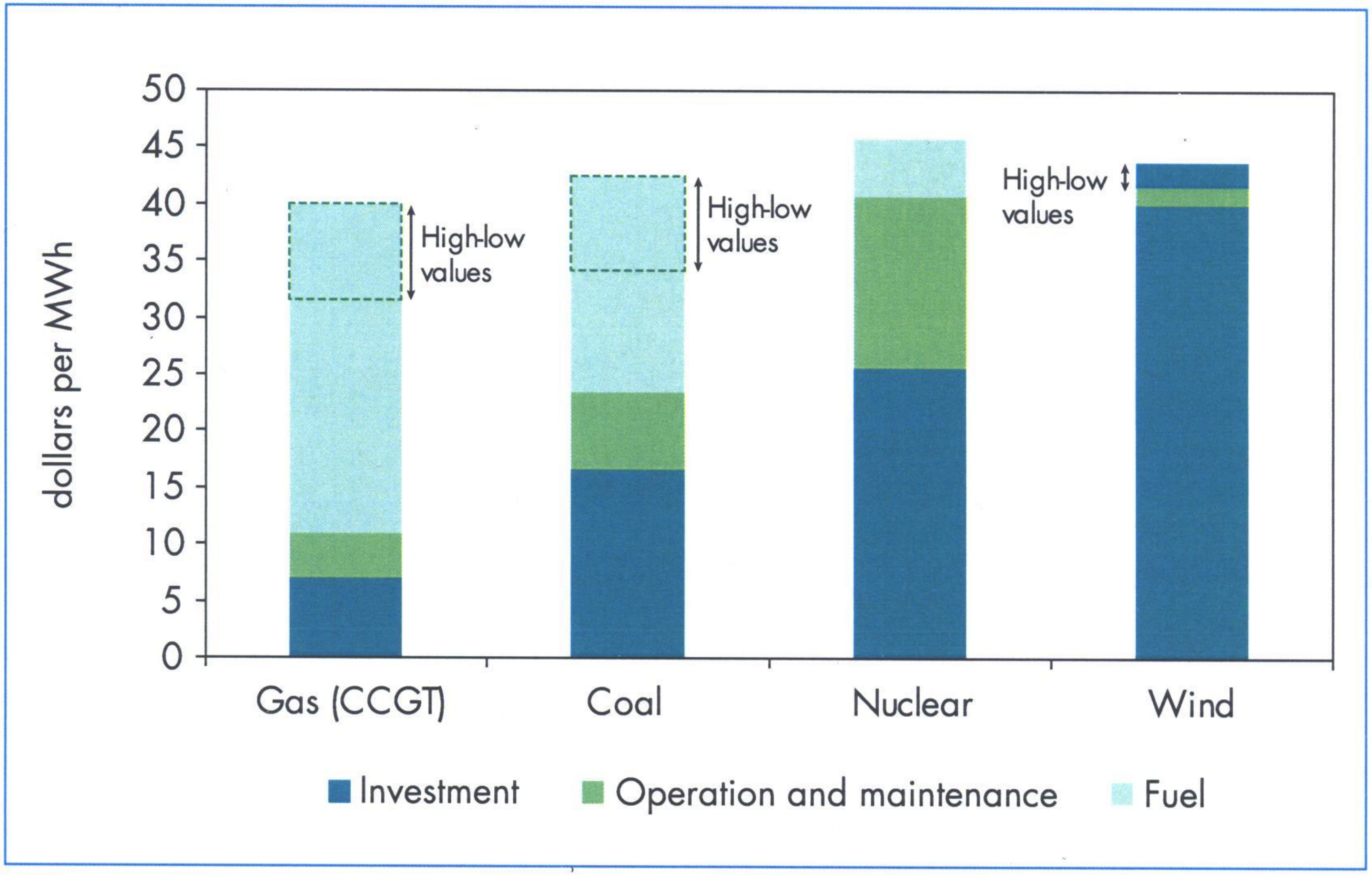
Challenges to gas market development

- Gas dedication to premium use (residential) with coal reserved for power
  - **Energy security concerns reduce supply to domestic gas sources**
- Gas-fired power pricing
  - **Competitive power pools?**
  - **Environmental adders**
  - **Peak shaving**
  - **Local user direct purchase**
- Gas turbines imported; coal plants manufactured in China
  - **Equipment cost of gas initially high during learning**
- First of a kind projects
  - **Anchor projects with assured off-take generally needed for infrastructure investment**
  - **Need for downstream market (local distribution companies and end-use expansion) to support infrastructure for power**

Benefits of gas market development

- Lower unit investment costs
- Shorter lead time in construction
- Smaller requirement for land occupancy and cooling water
- Modularity and lower economies of scale
  - Local grid networks for high reliability power;
  - Distributed urban power
- Higher energy conversion efficiency
- Lower environmental emissions
- Flexible load management and operational safety for local grids
  - Small unit unreliability (Guangdong 45%, often oil)
  - Local support at load center for long distance transmission
- Peak shaving
  - Limited pump storage capacity and long development

Figure 6.3: **Indicative Mid-Term Generating Costs of New Power Plants**

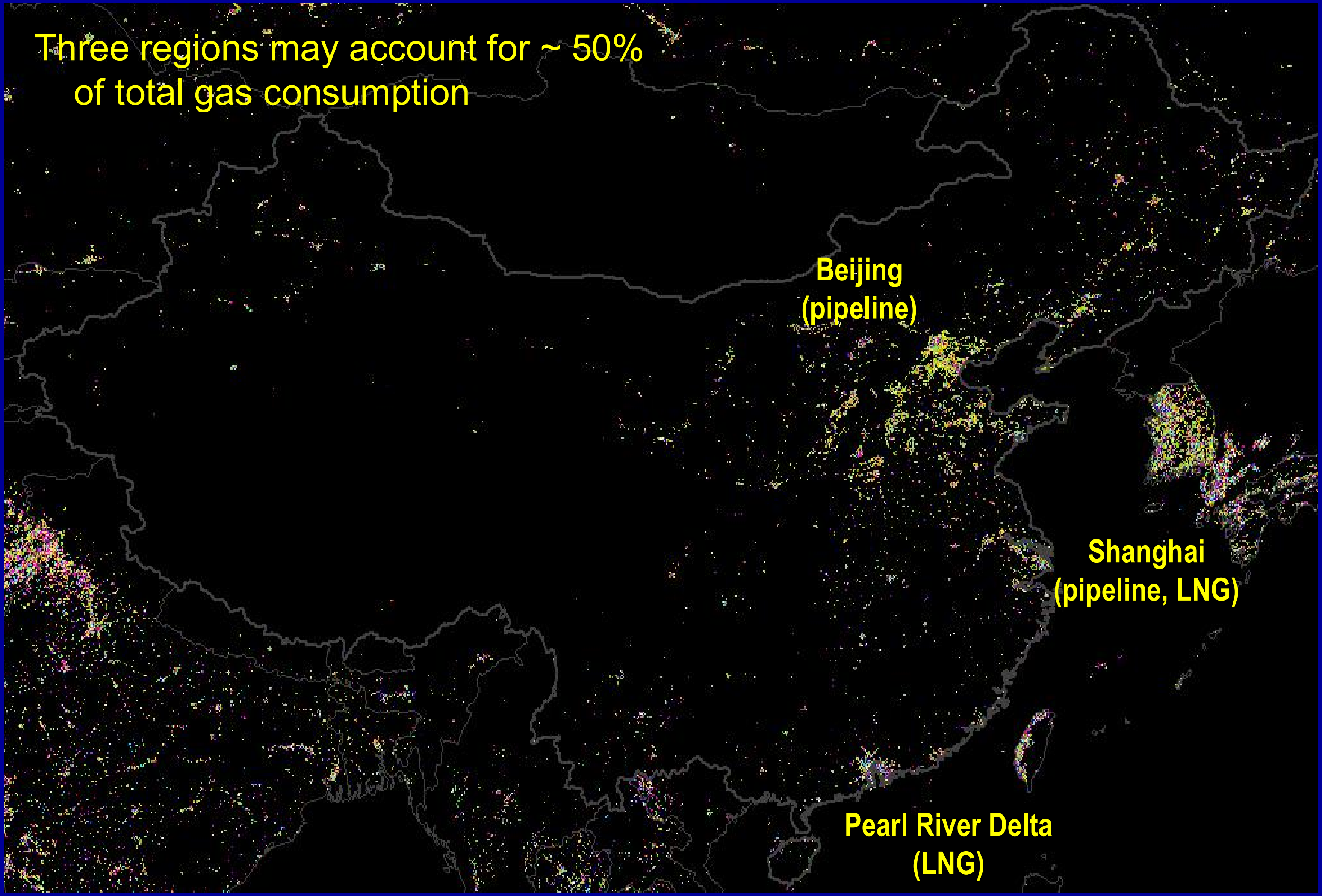


Source: IEA, World Energy Outlook 2004

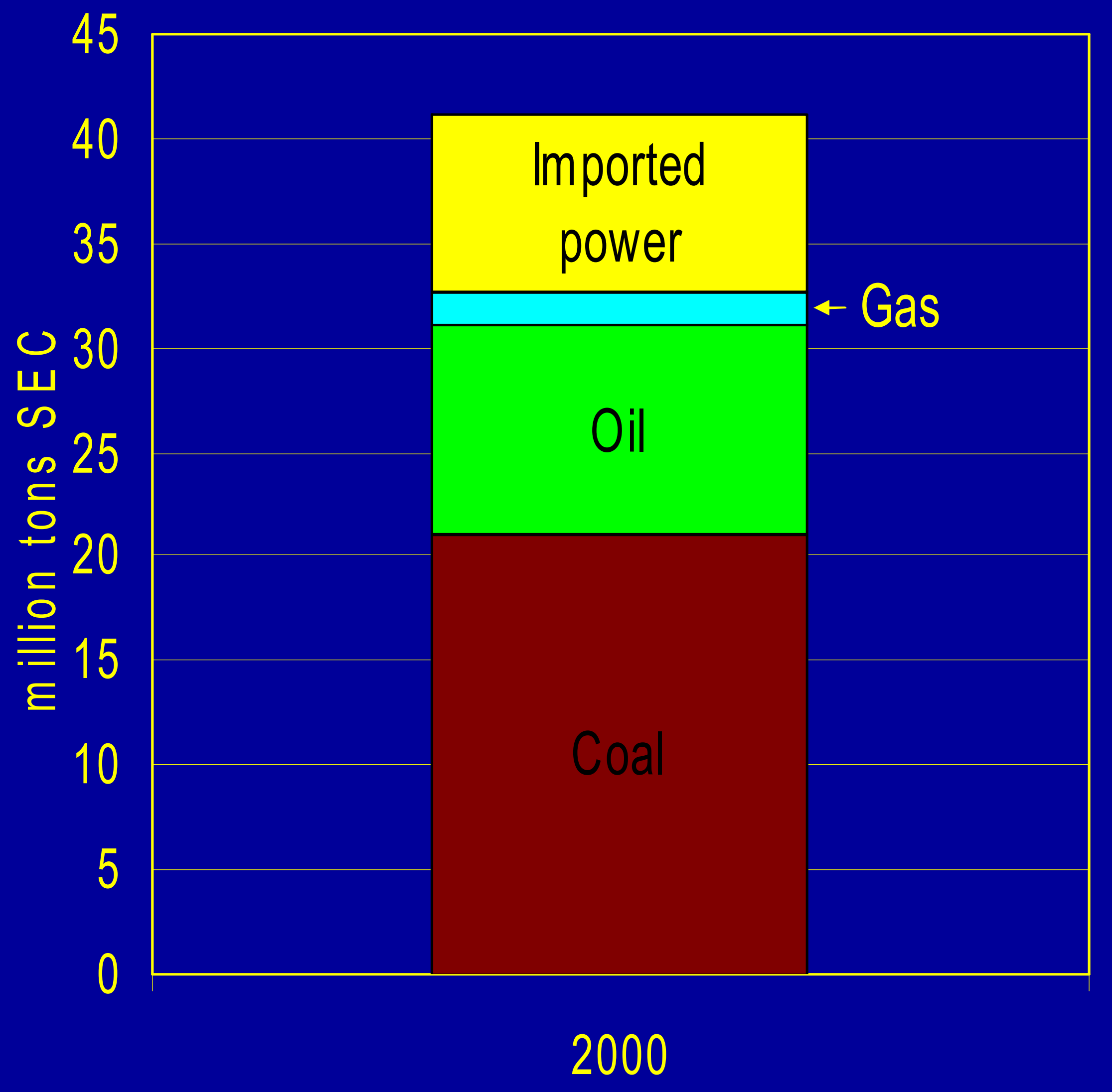
China case: Political Economy

- The positive capacity of the central government is sporadic; its negative capacity is substantial
- In periods of high growth, major decisions about economic policy are decentralized to provincial authorities
- After the division of corporate and ministerial organization in the 1990s, concentrated areas of political and market power lie with leading state corporations
  - Hybrid or dual firms predominate
- Successful examples of economic development are rapidly copied by other local authorities

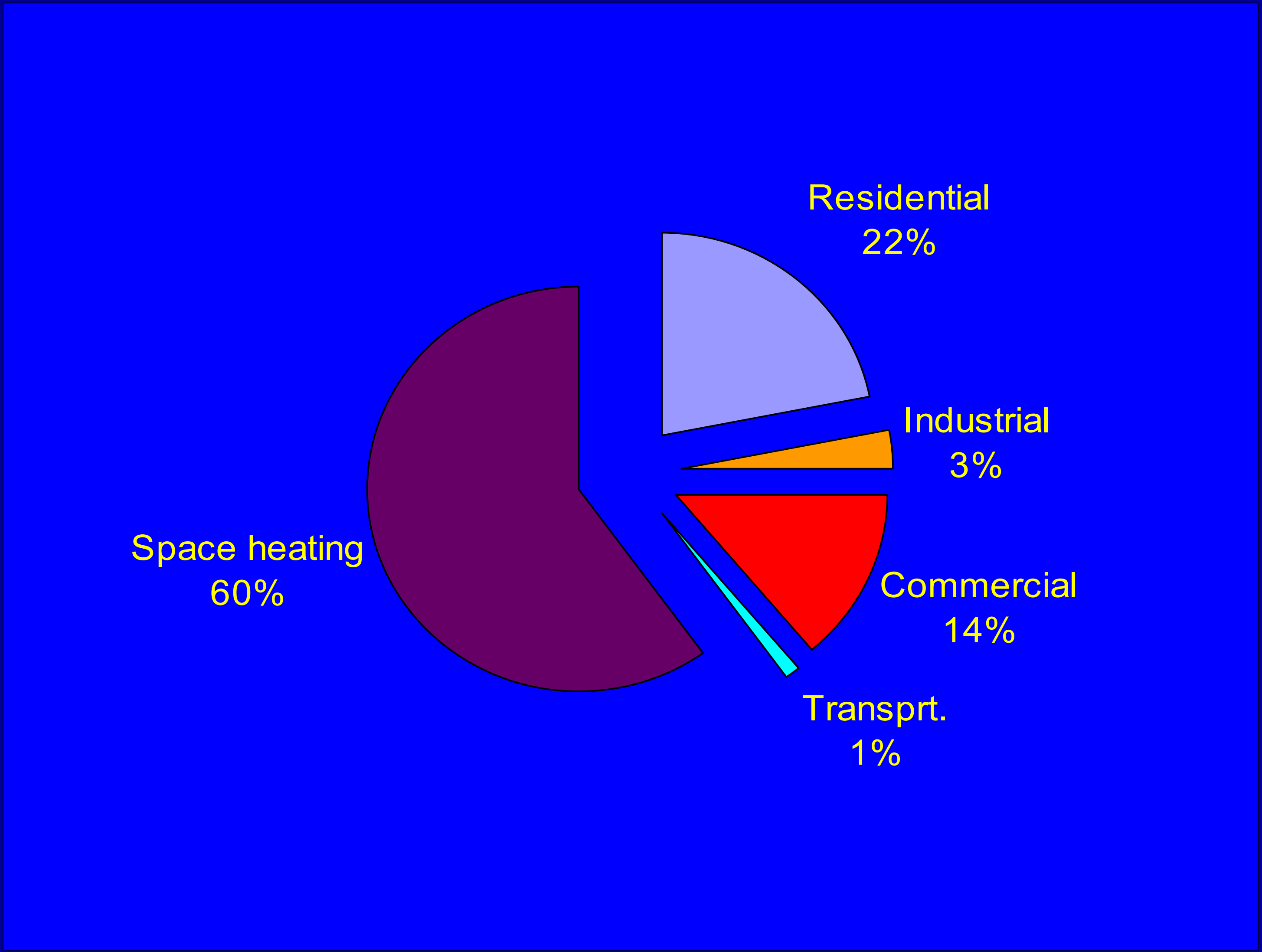
2. Potential Markets: Beijing, Shanghai,Guangdong



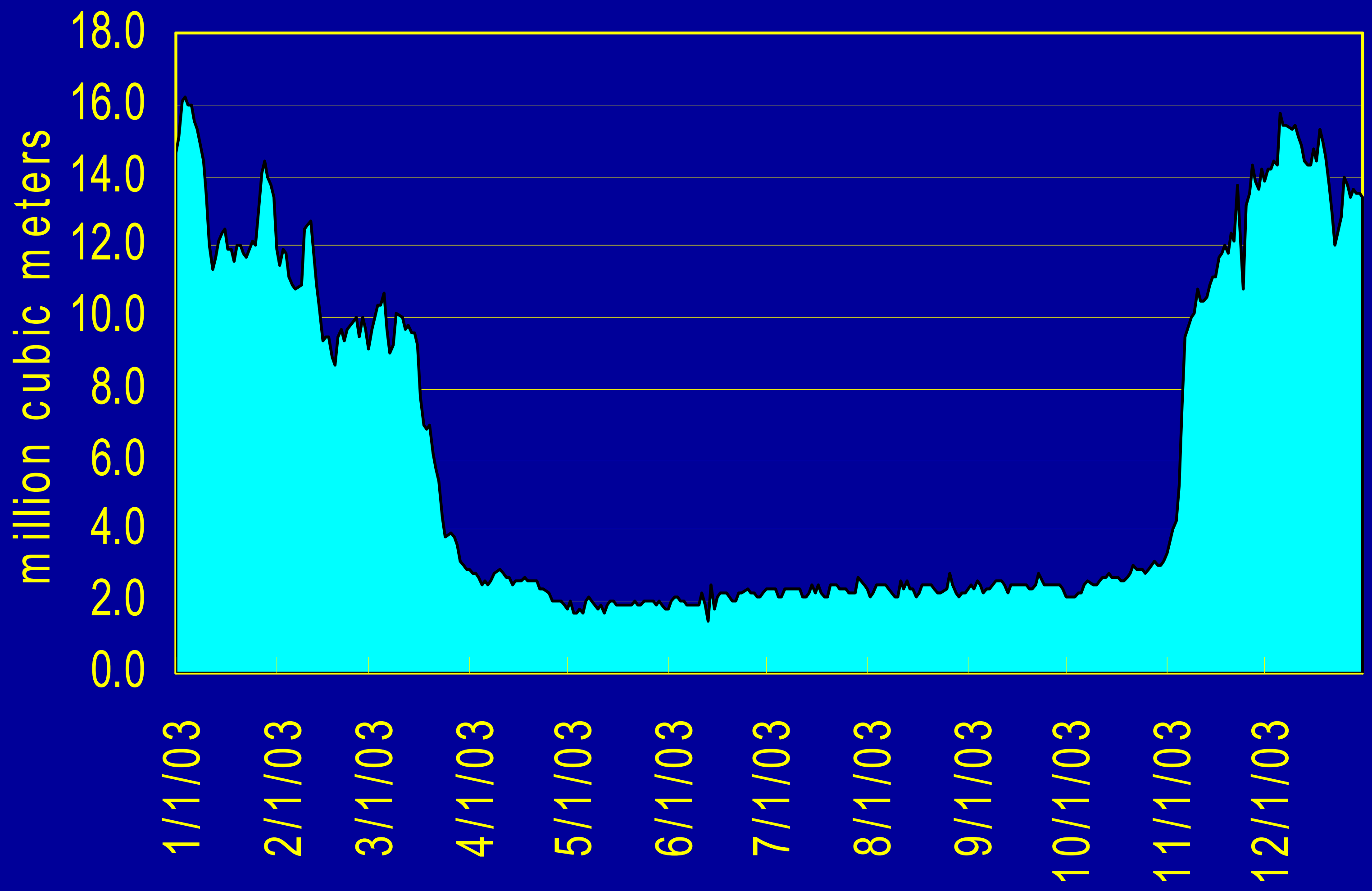
Beijing – Energy consumption



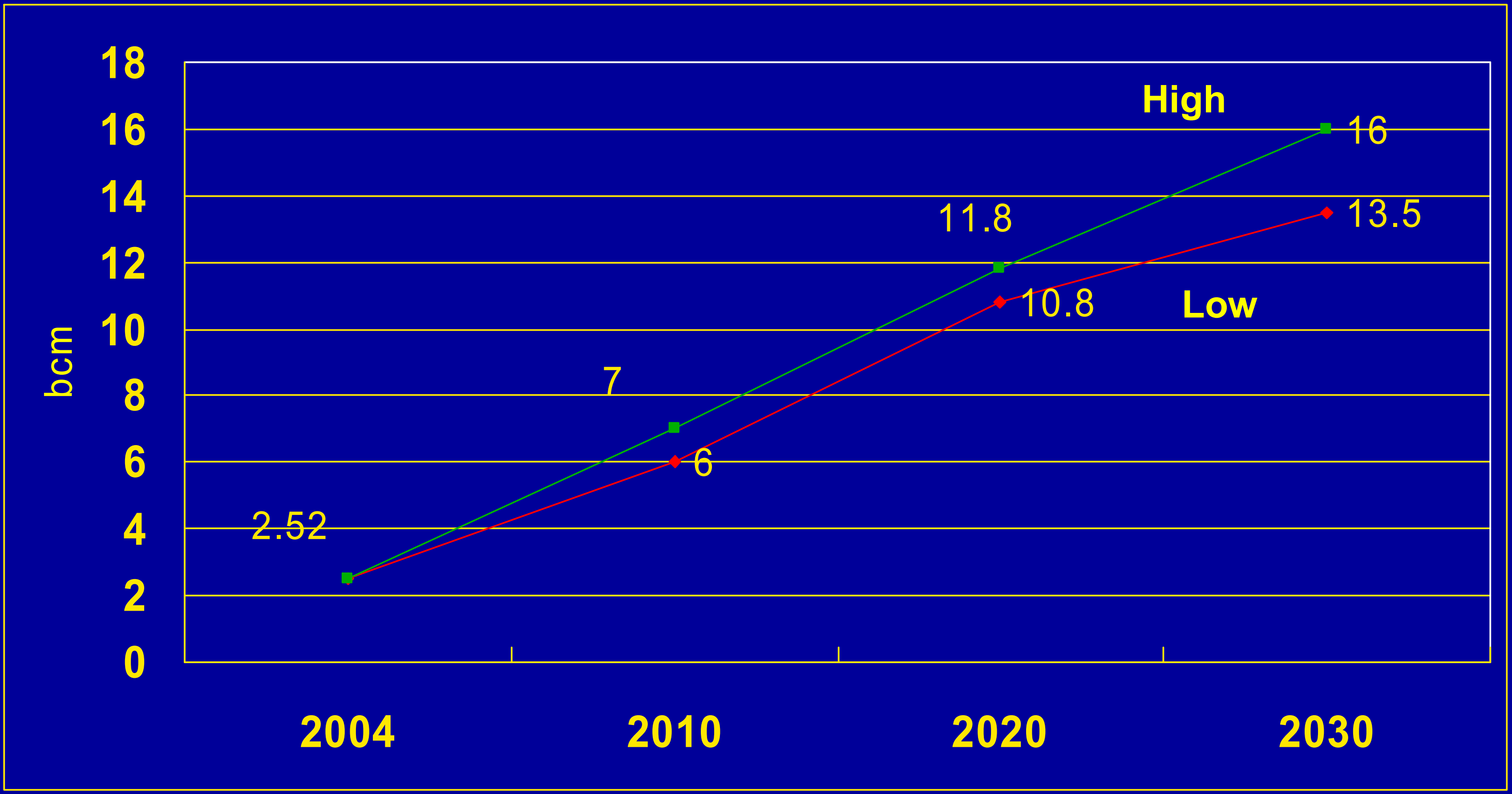
Beijing -- NG Consumption Structure (2003)



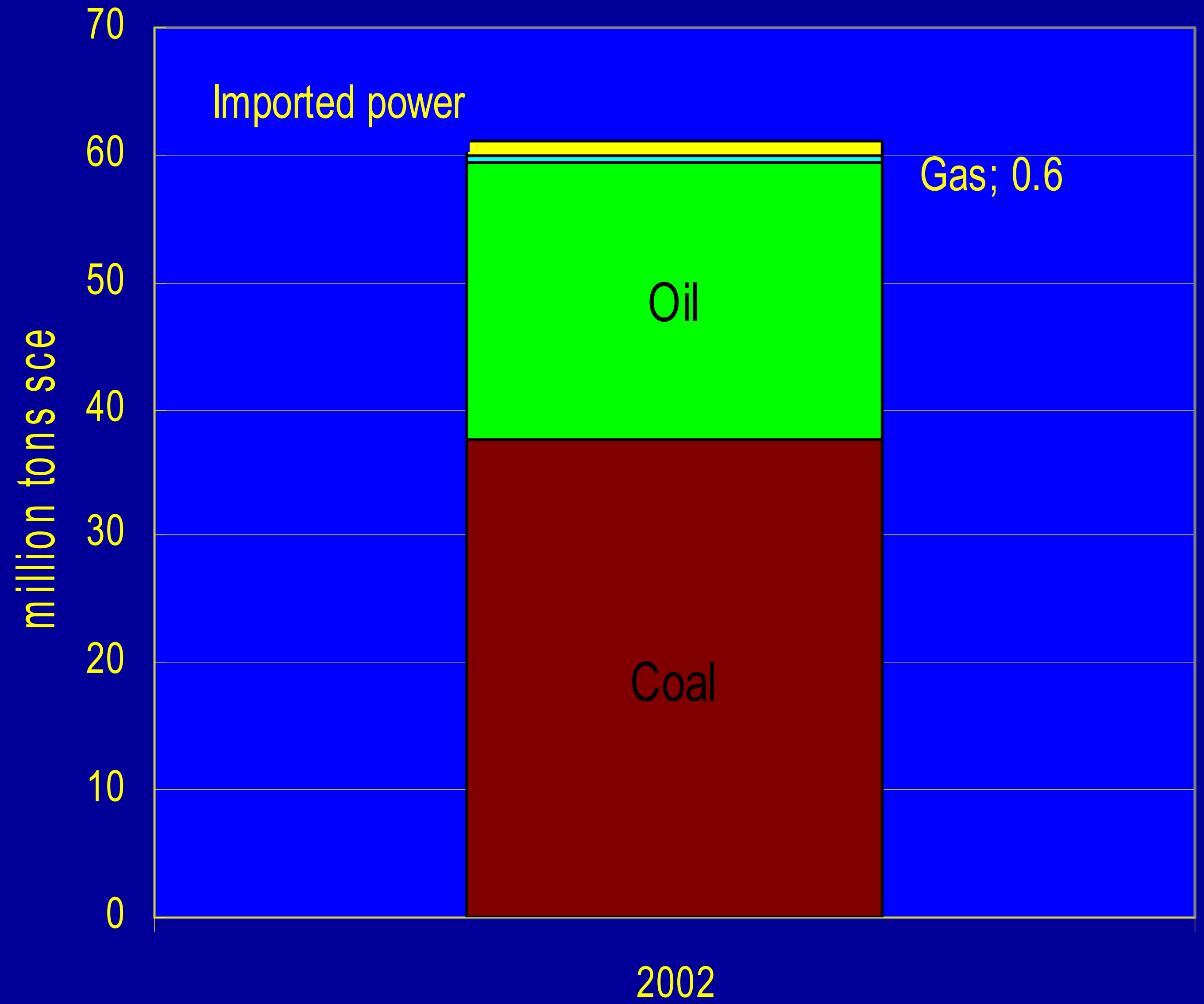
Beijing Seasonal NG Load Curve



Beijing -- Gas Demand Projection



Shanghai – Energy consumption

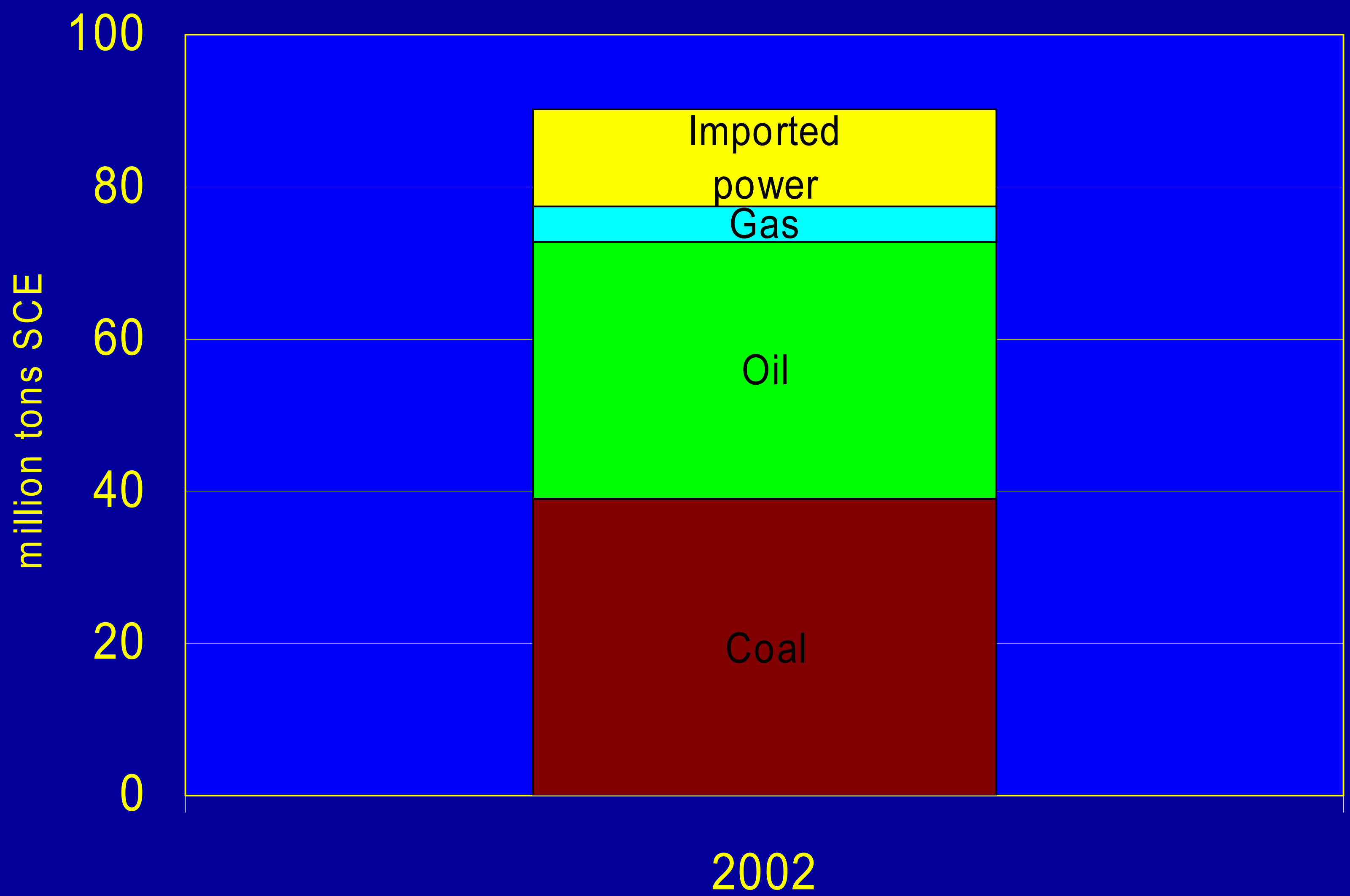


Shanghai – Future NG Applications

- CCGT
- Industrial boilers
- Distributed generation
- Heating/cooling

2 X 350 MW CCGT under construction

Guangdong – Energy consumption



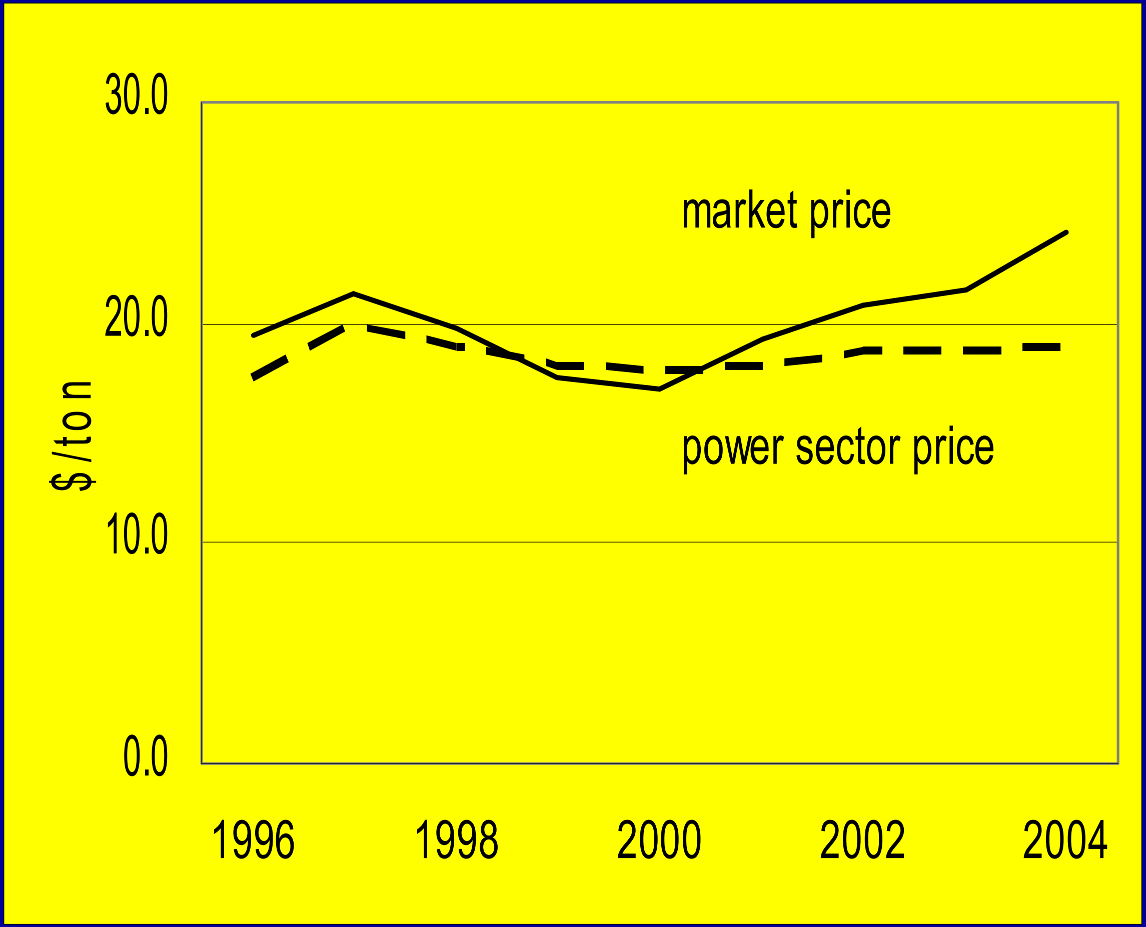
Guangdong – Natural gas application

- Electricity sector will be the largest off-taker
  - End 2004: 40 GW projected to 100 GW (2020)
  - 9 units nuclear @ 1 GW per unit
  - 7 or 8 (4x600) MW coal plants being built (17-20+GW)
  - 11 gas units (online 2006) or 3.3 GW of planned 30-40 units (10 GW gas fired power total) by 2020
  - Hydro contracts from West and Three Gorges (11-18GW)
- Residential and commercial sector
- Other industrial uses

Plans and prices: is the standard story about to change?

- Relative Electricity Costs: Guangdong, August 2004
  - ***Hydro***: 32-34 cents/kwh (fen in levelized costs);
  - ***Coal without FGD:*** 37 cents/kwh;
  - ***Coal with FGD***: 40 cents/kwh;
  - ***LNG*** (all in): 43 cents/kwh;
  - ***Nuclear***: 47-50 cents/kwh
  - \$4-4.50/mbtu gas = \$65-70/ton coal (no premia)

Mine mouth coal price



- 2004: Jan – Sept.
- Actual price for power generation is higher ($22/ton) due to sellers' resistance against planned price
- End-user prices are much higher, reaching $60 – $70/ton ($50 - $60 for power generation).

Supply Chains in Comparison

- **Coal**

Mine mouth → State-Owned Railroads → State-Owned Shipping → Plant

- **Natural Gas**

Well → Liquefaction → Shipping → Re-gas → Pipe → Plant

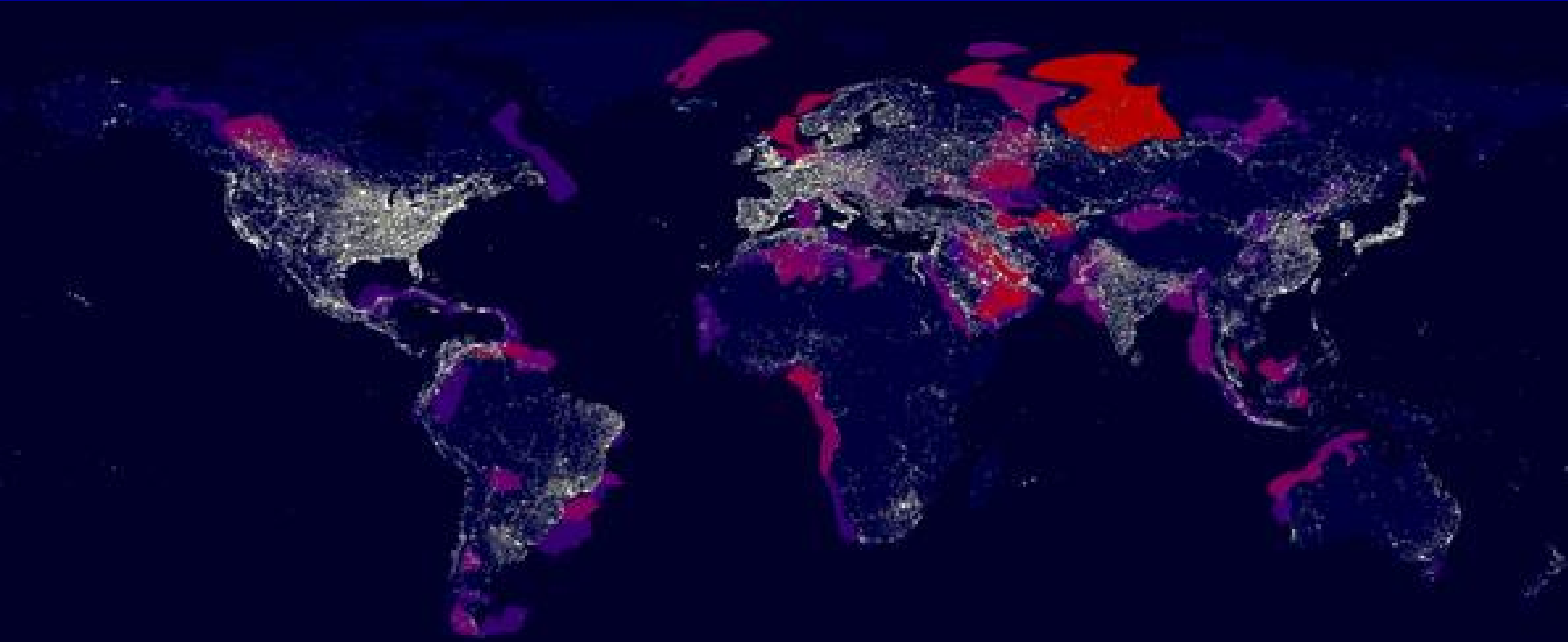
Non-price drivers of gas development in coastal cities

- Local autonomy (federalism)
- Environmental concerns
- Peak load curve and tariff controls
- Afford market development subsidies
- Exchange rates
- Capital Market reforms
- Industrial development: reliability and distributed power
- Chinese oil majors

Contextual factors for Gas Utilization

- Energy security
- Financial deregulation
- Regulatory decentralization
- Policy in downstream markets
- Infrastructure development support (one time costs)
- Management of expanded market development risks
- Gas/coal relative price formation in Asia- Pacific region (levels and volatilities)
  - Supplier needs and agendas (Gazprom)
  - International politics (Iran)

Tapping the World's "Infinite" Gas Resources



White: where the lights are on, satellite imagery
Blue → Red : Gas resources, with increasing size (USGS)

Source: Baker Institute (Rice) and PESD (Stanford) Joint Study on the Geopolitics of Gas (CUP, forthcoming

Revolution in Global LNG Markets

- Shift from "old world" defined by:
  - Few importers
  - Rigid long-term, take-or-pay contracts with destination clauses
  - Muted price incentives to divert cargoes
  - "Buyer takes the volume risk and seller takes the price risk"
  - Captive customers of regulated utilities ultimately backed contracts

Revolution in Global LNG Markets

- Toward a "new world" defined by more flexible LNG trade and driven by:
  - Liberalization of gas and electricity markets
  - Declining LNG costs (esp. liquefaction and re-gas)
  - Growth of new markets (Spain, US, UK)
  - Entry of energy super-majors to gas trade
- Flexible LNG trade will integrate US and European gas (and electric power) markets

Pricing: Volatility in global gas markets

- Price de-linking from oil (fuel oil and distillates)
  - Gas at projected scale no longer a side product of oil
  - Flexible spot markets separate gas from oil prices
  - Gas and oil seen as non-substitutable quality products
  - Low cost oil reserves lower than gas reserves
  - Volume justifies specialized contracting
- Increase spare capacity
  - Increase supply: permits on re-gasification facilities
  - Decrease demand (diversified power portfolio)
- Regulation to encourage long term off-take contracts
  - Need for anchor projects (creditable for CO2)
- Storage increases

Market Structures

- Supply and volatility issues
- Risk bearing and distribution
  - No build out without buyers
  - No buyers if excess volatility (that limits capacity to sell)
  - Optimal portfolio (buyers and sellers)
    - Long term contracts (with moderate premia)
    - Flexibility mechanisms for peak and high demand
    - Merchant risk (upstream/scale) and hedges
- First mover effects
- Feedback from markets into policy

Pacing (organizational issues)

- Oil companies and gas culture
- Risk re-distribution
  - New hedging or risk bearing mechanism to absorb quantity risks upstream
- Mercantile energy security perceptions
- Scarcity and price increases in equipment and downstream facilities (ships)
- Supply nation political economics
  - Limited contracting management capacity
  - Low absorption capacity for budget growth
  - Domestic gas use at regulated prices

Annexed materials

Indian nuclear deal

Brazilian biofuels deal

http://pesd.stanford.edu/

Nuclear Deal In India

- U.S. - India technology transfer could facilitate the installation of 30 GW of new nuclear capacity.
- This would save 230 million tonnes of CO_2 if it displaced only coal capacity and 87 million tonnes if it replaced gas.
- In practice, nuclear would likely replace a mix of both coal and gas
  - emissions reduction would fall between 87 and 230 million tonnes.

India Reference Scenario

	Installed Capacity (GW)[1]	
	2002	2020
Coal	69	127
Gas	13	45
Nuclear	3	9
Total Capacity[2]	116	252

[1] Source: World Energy Outlook 2004

[2] Total capacity includes coal, gas, oil, nuclear, hydro, and renewables.

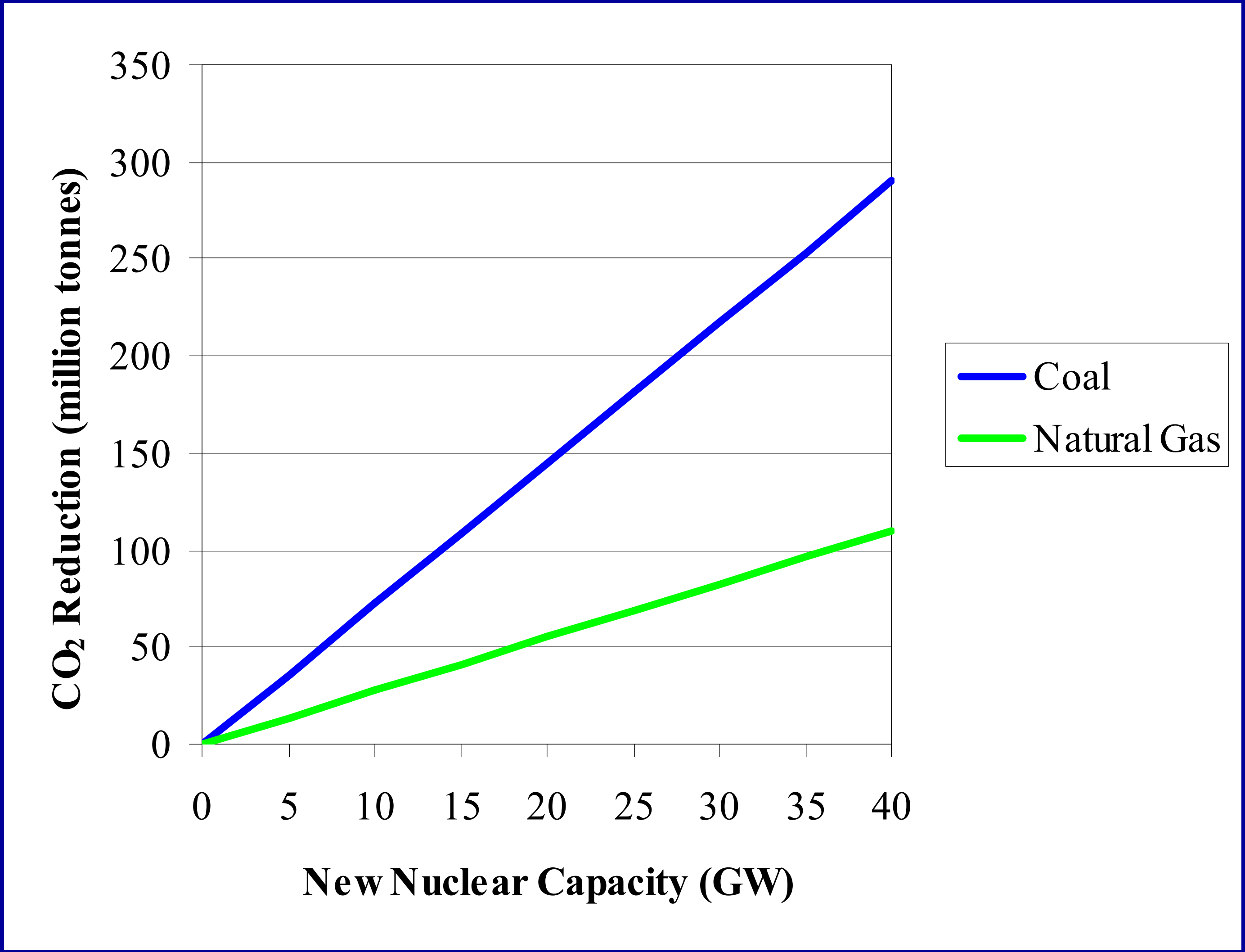
India Deal: Load Factor and Carbon Intensity Assumptions

	Nuclear	Subcritical Coal	CCGT
Load Factors	0.90	0.85	0.90
Emissions rate (tonne CO_2/GWh)	0	920	350

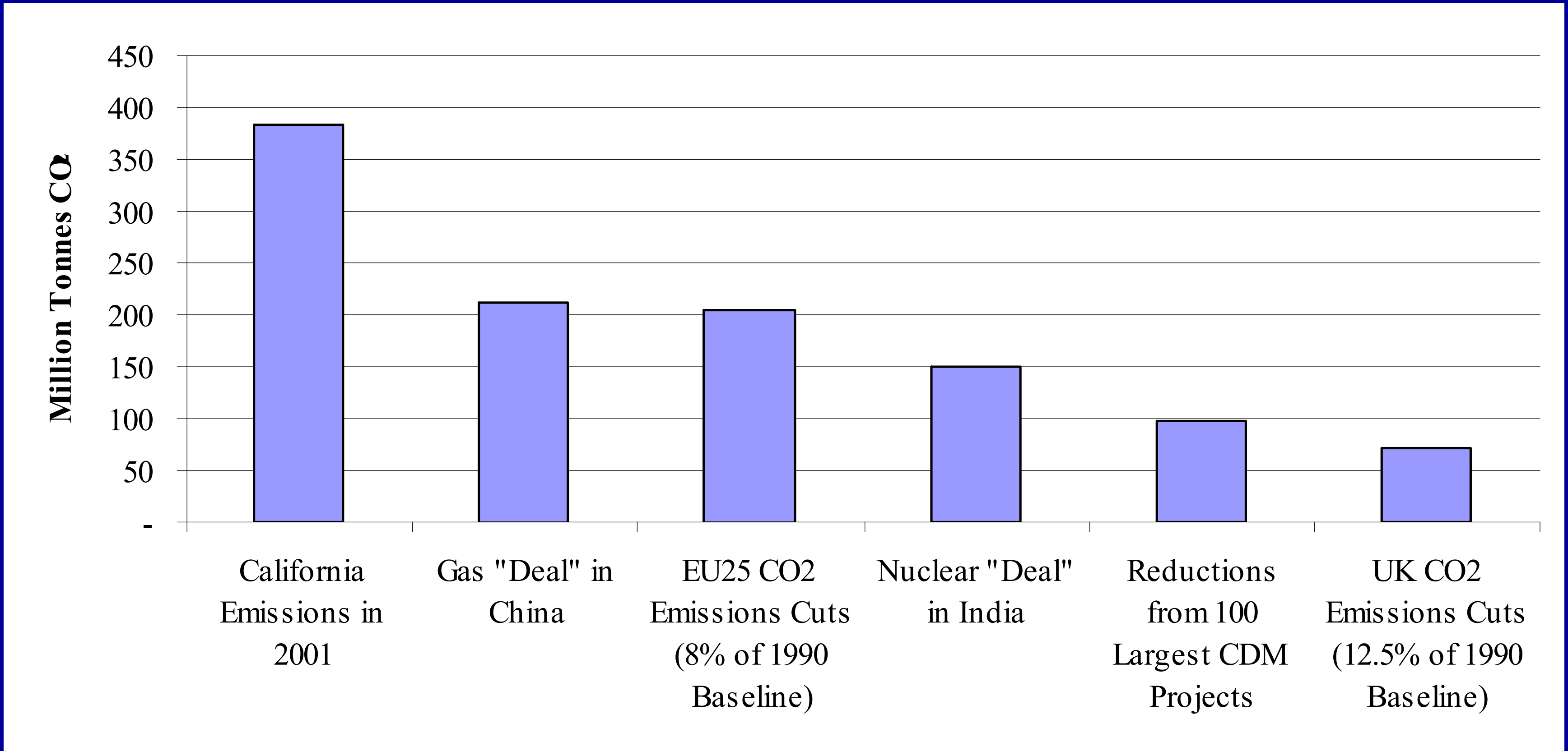
India Deal: CO2 Savings

	Nuclear Replaces Coal	Nuclear Replaces Gas
Displaced Capacity (GW)	32	30
Total Generation (TWh)	237	237
CO_2 Emissions Reductions (million tonnes CO_2/year)	218	83

India Deal: Carbon Implications



CO_2 Savings in Perspective



Amazonian deforestation: sources

- Mineral development
- Small farmers
  - Interregional
    - Government directed colonization
    - Federalization of lands
    - Infrastructure and road led
    - Network flow from origin regions once established
  - Intraregional
    - Productive (full deforestation)
    - Non-productive (less initial deforestation, but more plots
      - Speculation
      - Sales to large holders (capital gain) and movement
- Large farms and ranches
- Urban development (Manaos)

Amazonian deforestation: dynamics

- Minerals
  - National security driven
  - Export earnings from commodities
  - Tax credits
  - Input subsidization: electricity
    - Tucurui
  - Labor force spillover

Amazonian deforestation: dynamics

- Small farmers
  - No land acquisition costs
  - No taxation of farm income
  - No taxation of capital gains
  - No stumpage fees or logging fines
  - Weak macroeconomic stability encourages land speculation
  - Failure to provide agricultural technology or credit encourages turnover
  - Insecure title leads to social violence and relocation
  - Opportunity costs exceeded land rents without government action (pace of deforestation induced)

Amazonian deforestation: dynamics

- Large farmers and ranchers
  - Subsidies from competing agencies
  - Available credit and titling capacity allows land acquisition from relocating farmers, after subsidized colonization initiated deforestation and created marketable assets
  - Land reclassification away from forest preservation (cerrado)
- Urban development
  - National security
  - Zona franca
  - Energy subsidies (fuel prices and regional transport)
  - Little actual surrounding deforestation

Amazonia deforestation: deal structure

- Eliminate subsidization (no internalization of carbon values)
  - Tax income and stumpage fees for productive farmers
  - Capital gains taxation for relocating farmers
  - Opportunity costs compared to sustainable forestry concessions
    - Private property rights enforcement better than regional government
  - Biofuels development on cleared land for family income
- Domestic costs avoided from climate change
  - Hydrology shifts in Amazonia precipitation patterns will curtail Southern rains and reduce value of hydropower system
- Carbon storage payments internationally

Annexed materials

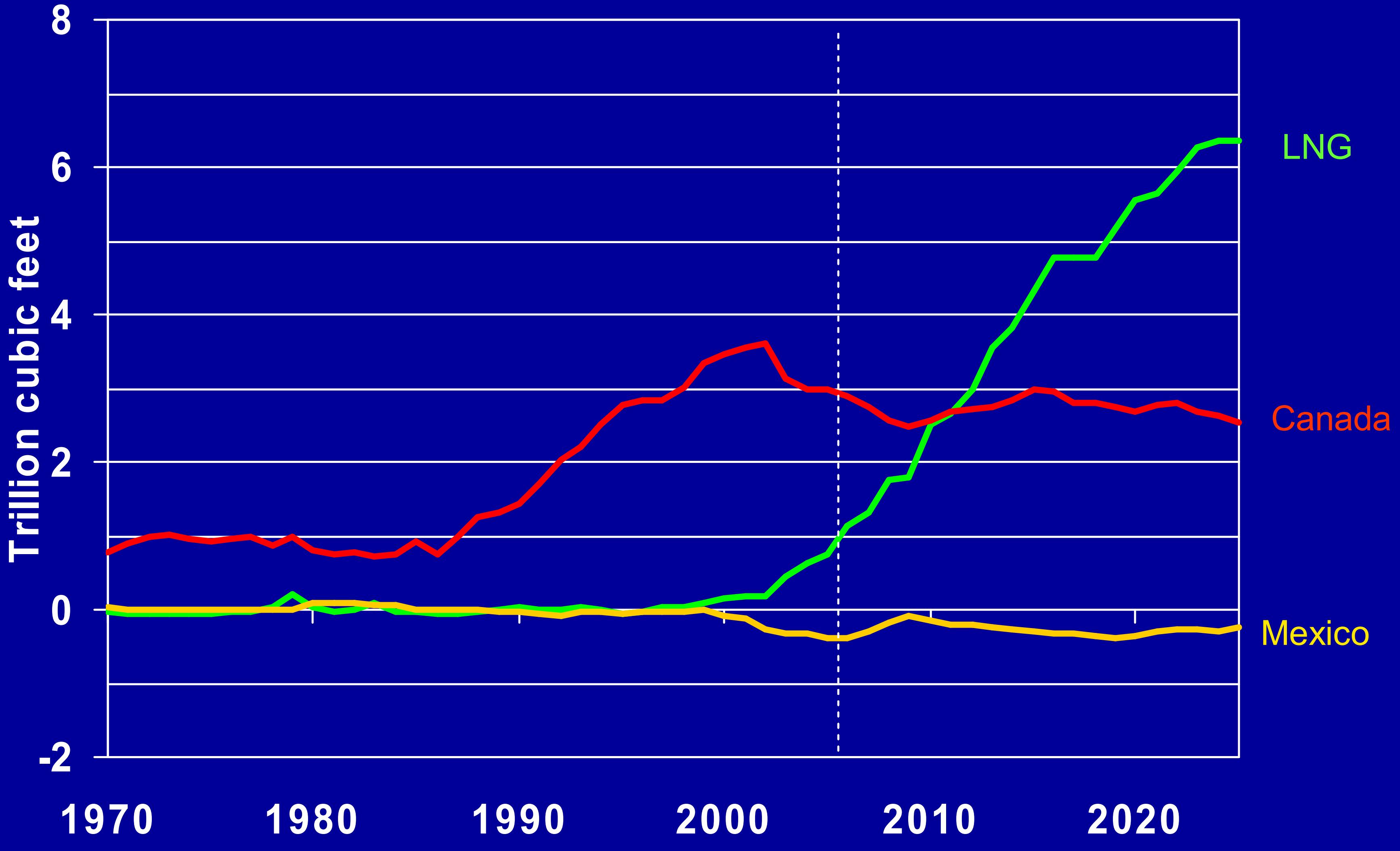
LNG markets

Technology Strategy

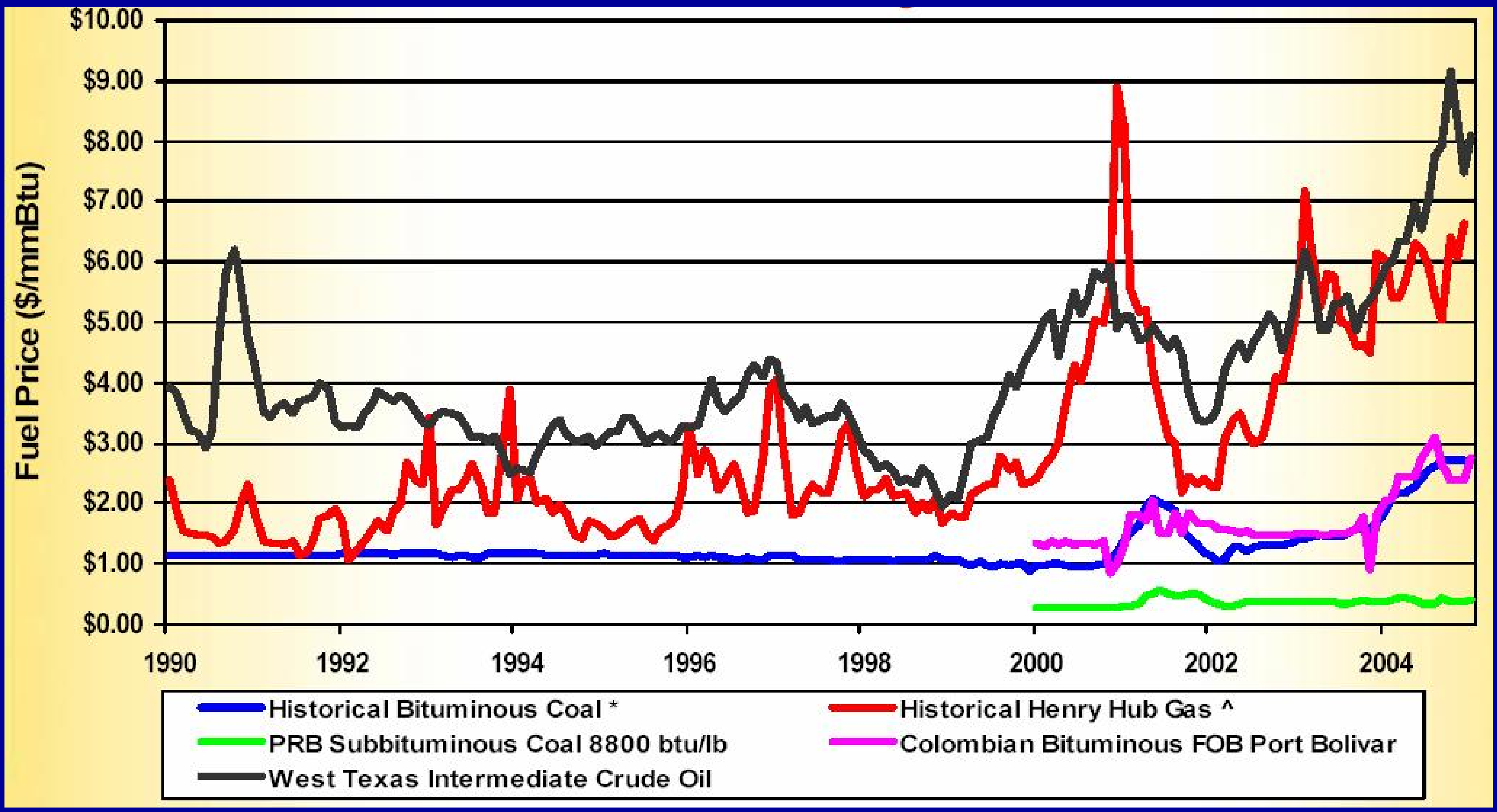
http://pesd.stanford.edu/

Net US Gas Imports, 1970 – 2025

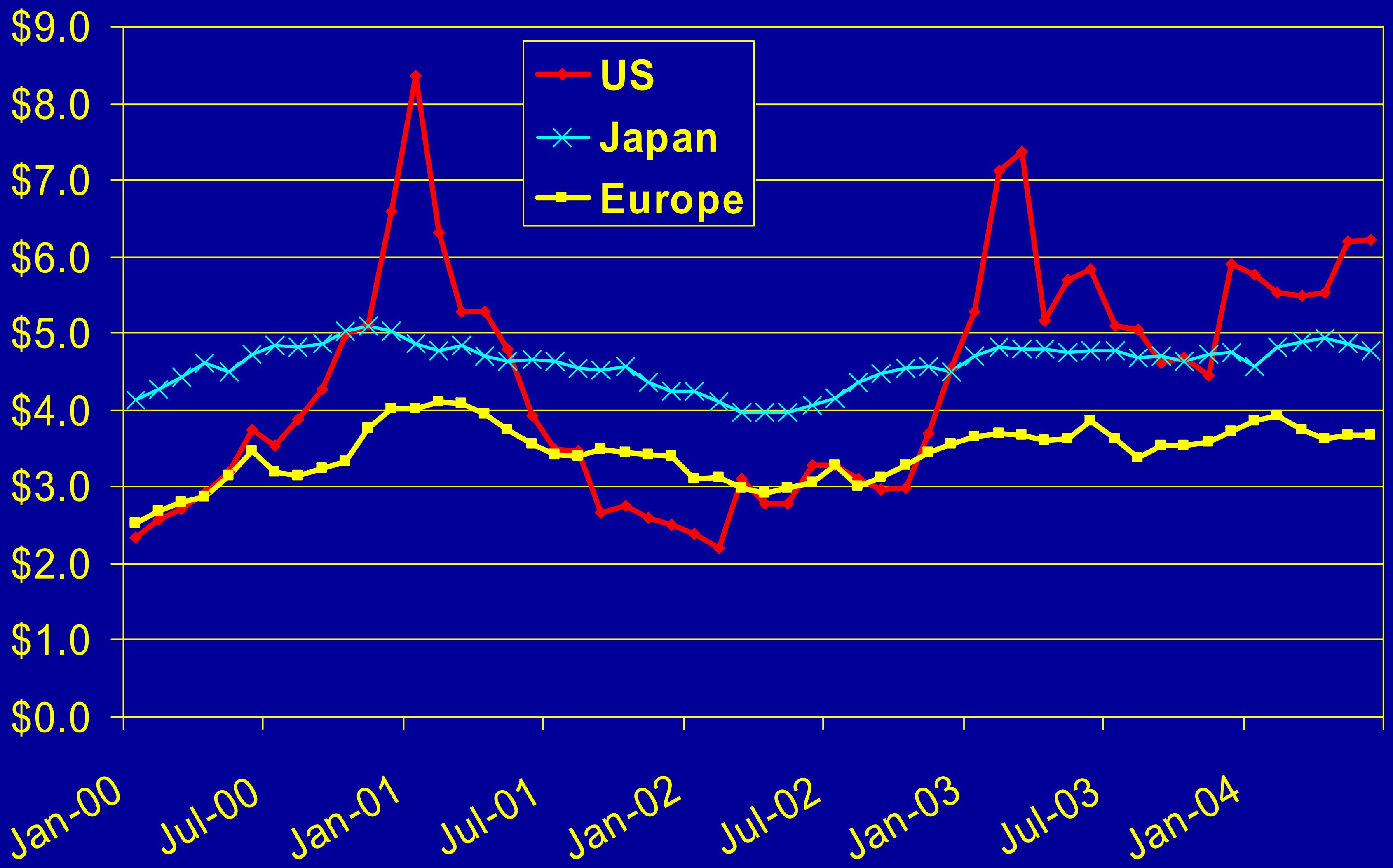
EIA-AEO 2005



Relative prices: Coal, gas ,oil

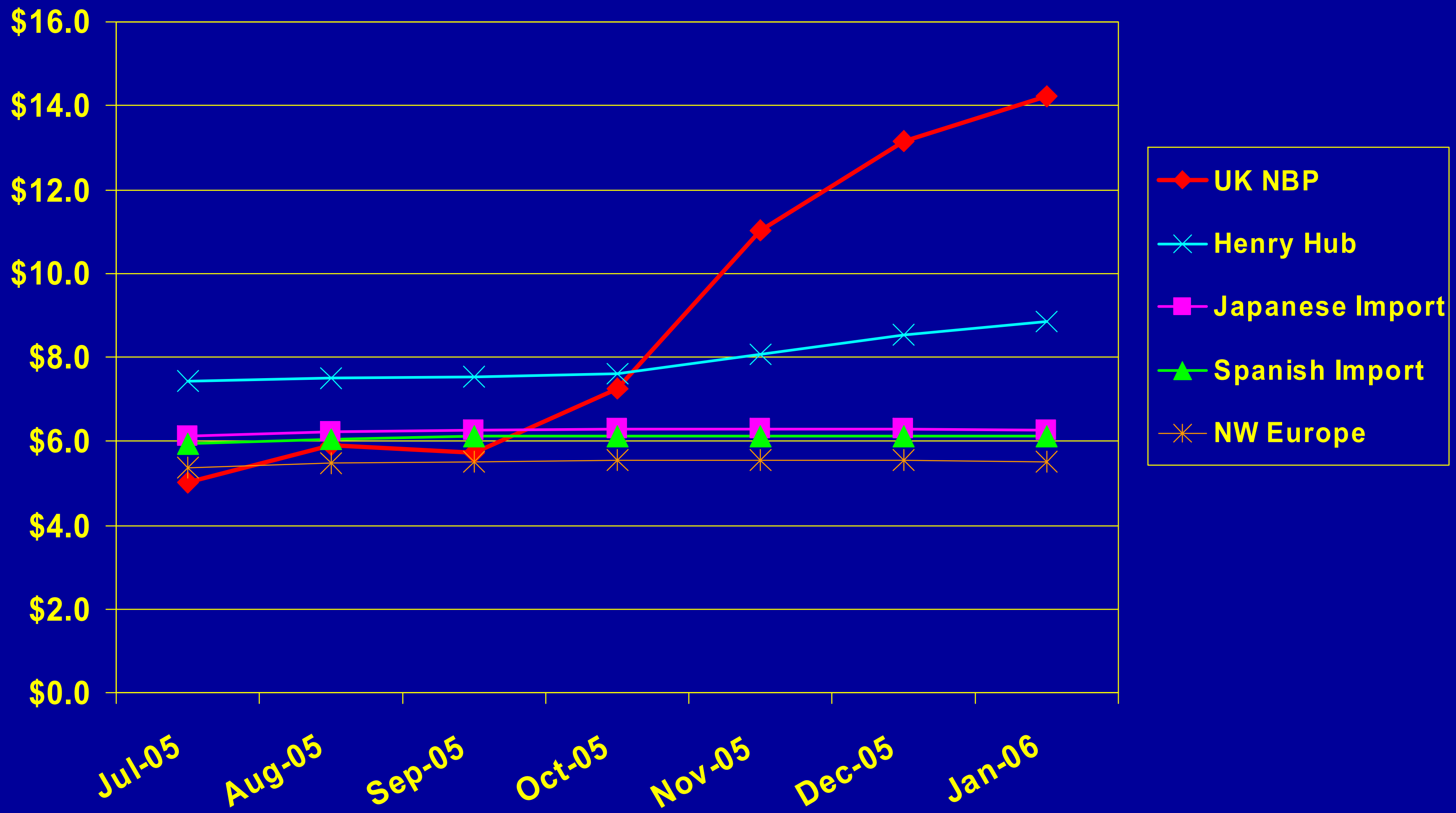


US Spot, Japanese & European LNG Prices
($/MMbtu)



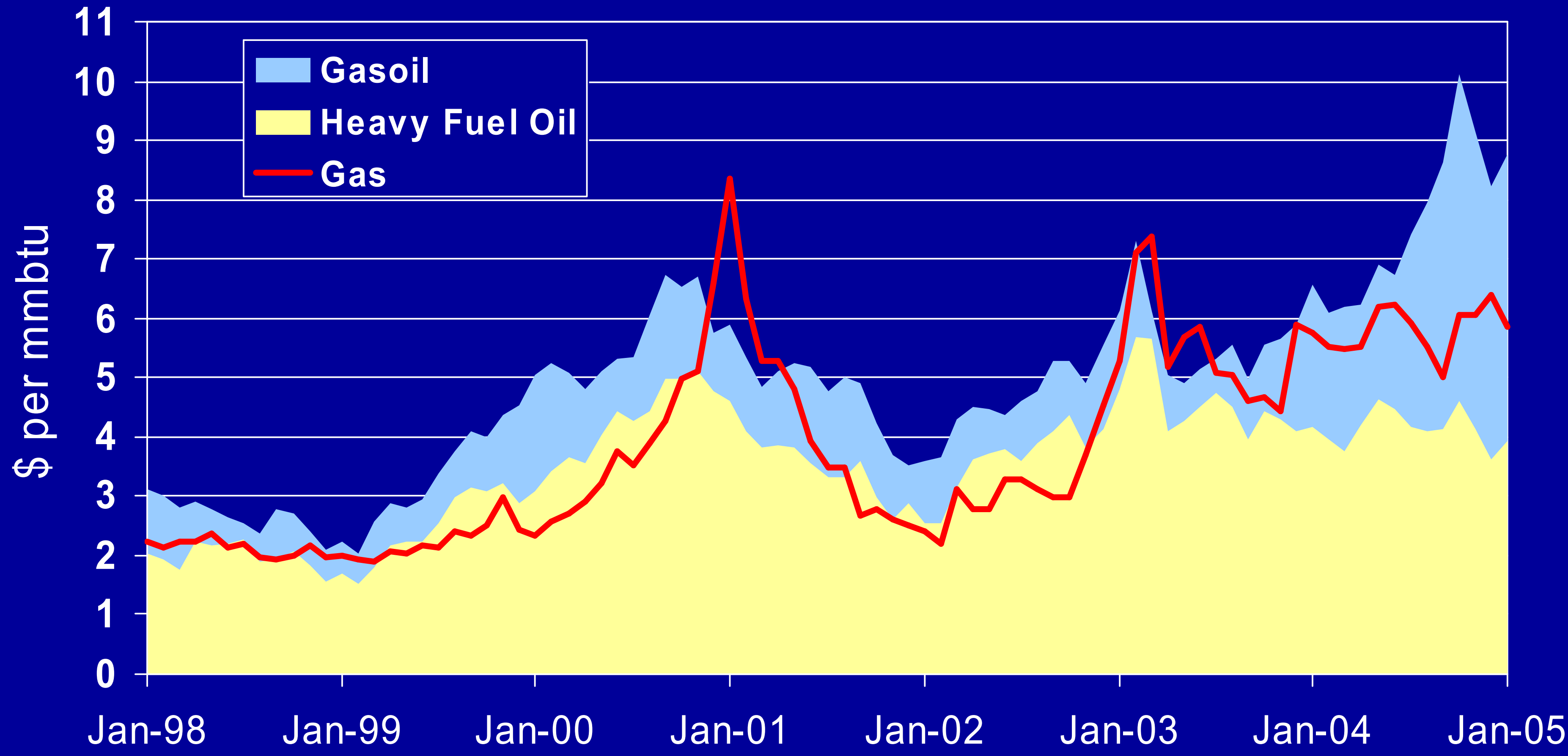
**Henry Hub for U.S. data, average of Japanese & European landed LNG prices*

Forward Prices in Key LNG Markets
(US$/MMbtu; 20 July 2005)



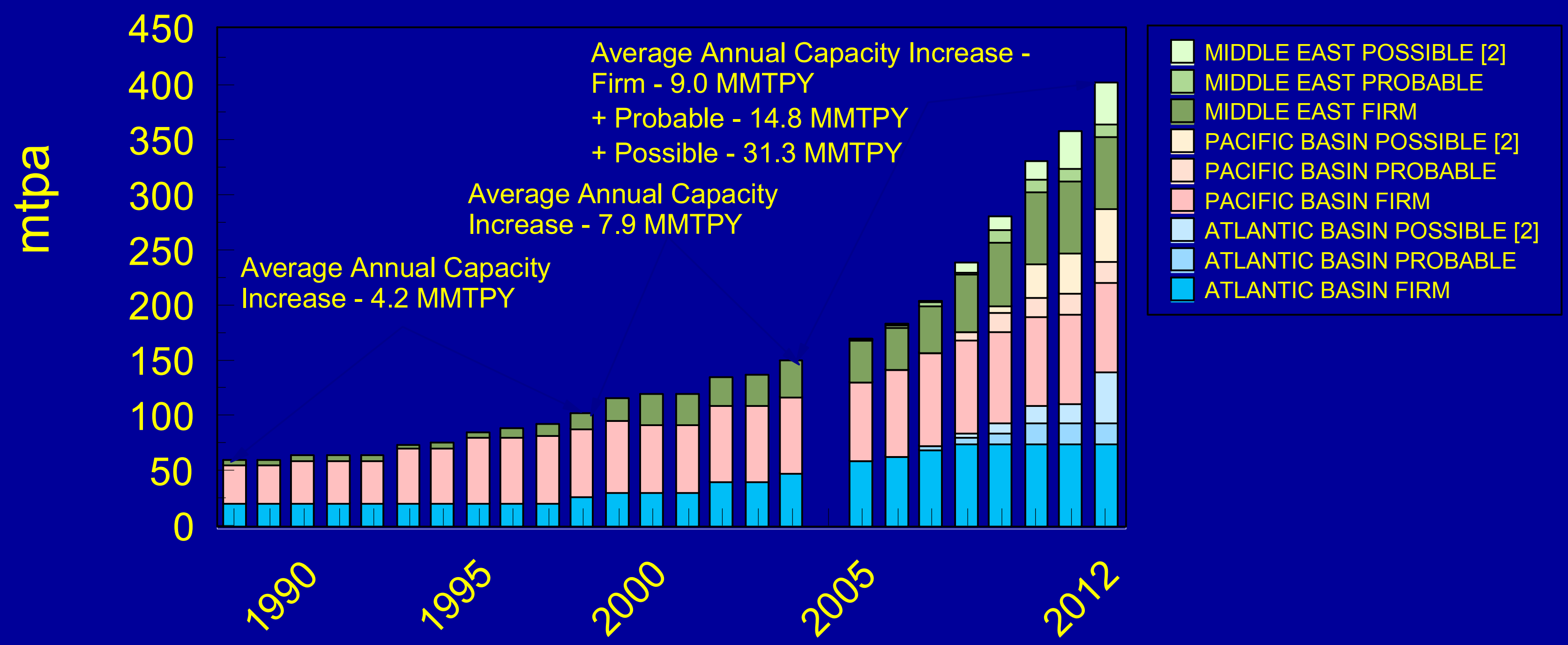
Source: Heren LNG Markets

US Gas Prices Linked to Oil Products



Purvin & Gertz 2005

Global LNG Supplies



Source: James Jensen

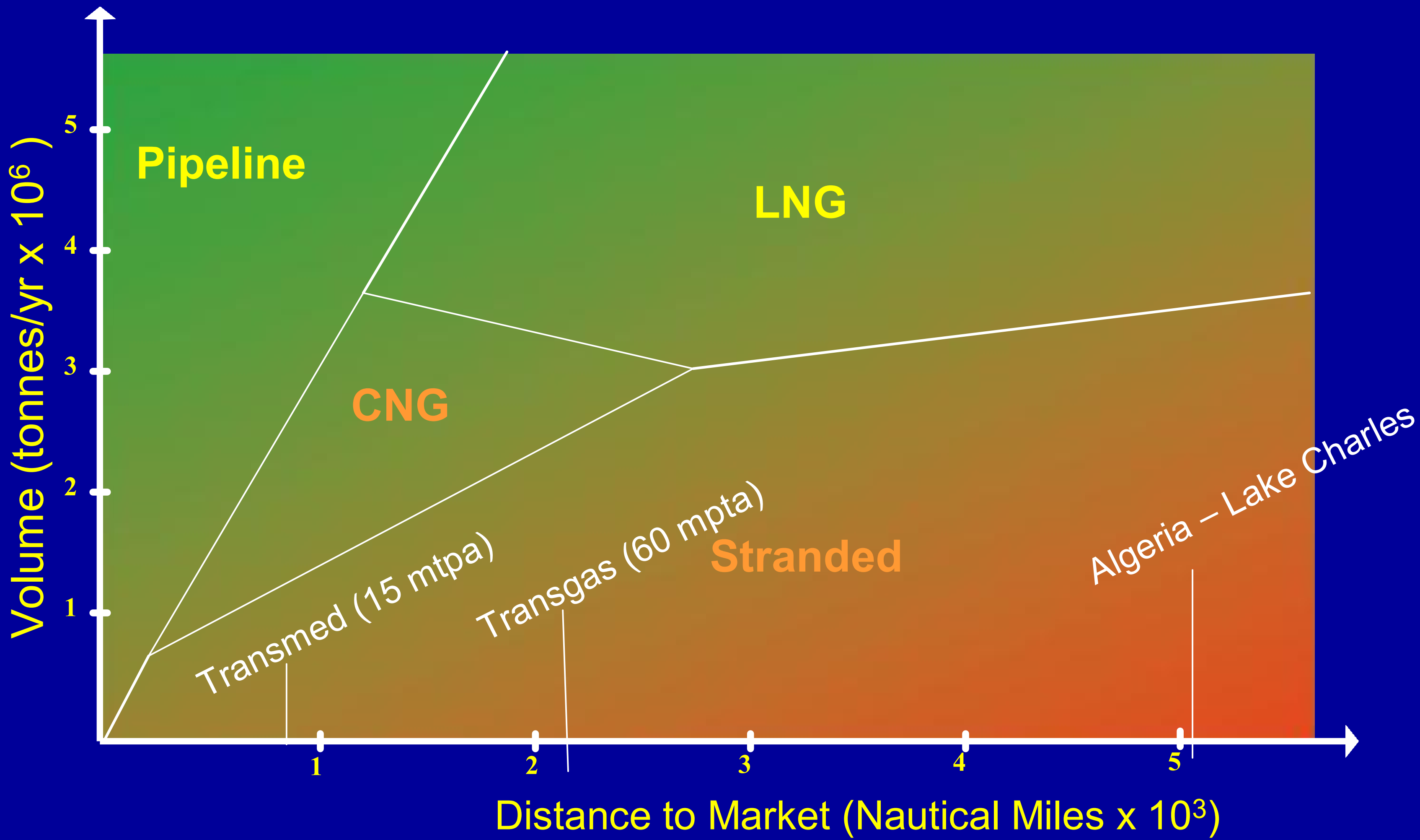
Factors Driving U.S. Natural Gas Demand

% Δ Gas Demand =

+ 1.000 x % Δ Real GDP
+ 0.250 x % Δ Heating Degree Days
+ 0.075 x % Δ Cooling Degree Days
+ 0.075 x % Δ Real Oil Price
- 1.000 x % Δ Real Gas Price (lag)
- 0.300 (constant)

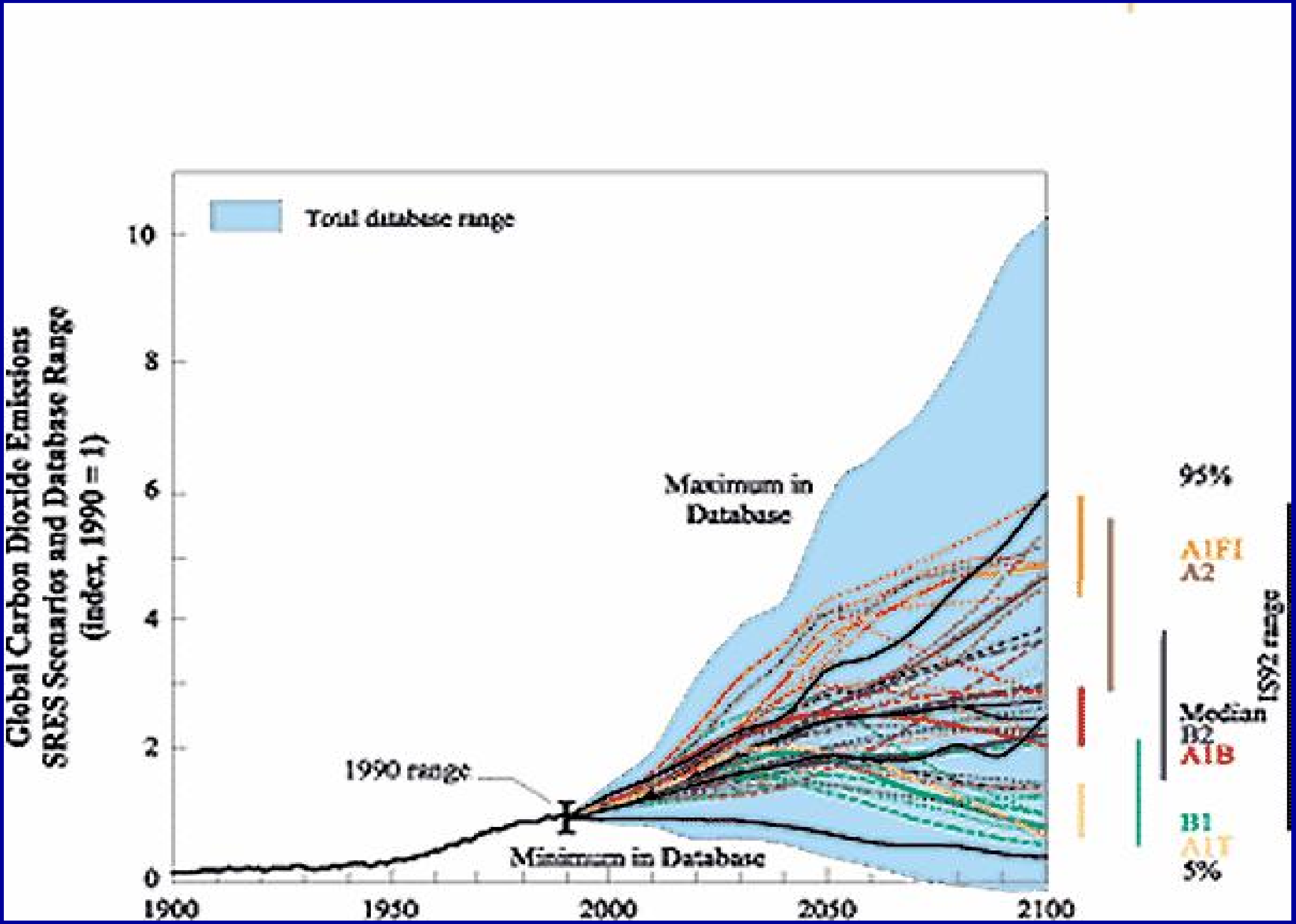
Source: Deutsche Bank

Volume, distances determine transit mode

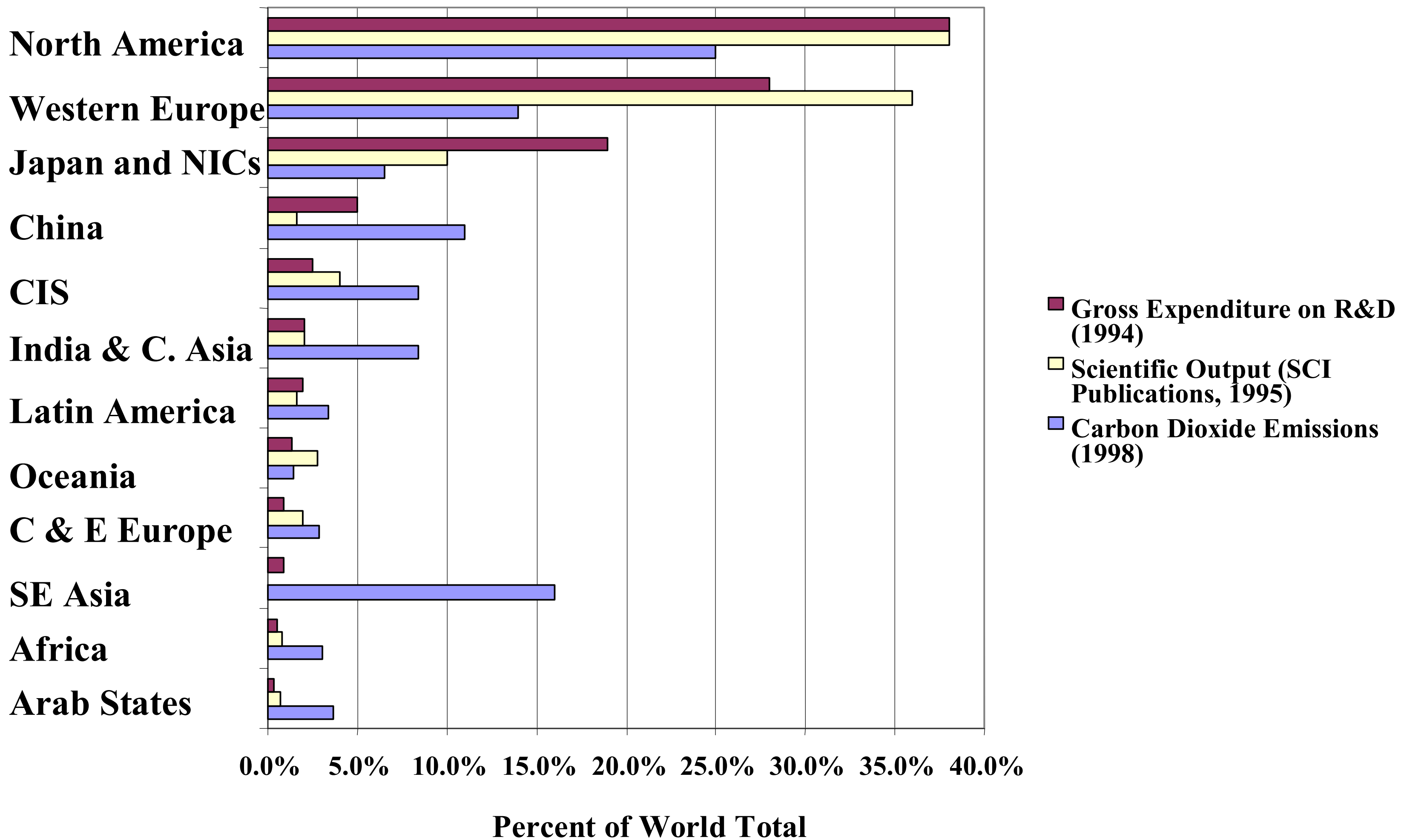


CE Tech

Full Range of Published Scenarios



Top Innovators and Emitters by World Region



Elements of a Technology Strategy

- Diverse Country-Based Initiatives
  - Loose international coordination among nations with diverse national cultures of innovation
- Price and technology progress are not either/or
  - Politically acceptable price signals tend to operate at margins, while vintage shifts may require dedicated policy programs
- Technology development involves a long pipeline from scientific conceptualization through diffusion of commercial production
  - Common pitfall: premature selection of winners
  - The pace of development along a pathway is affected by predictable and diverse problems that will crop up along the pipeline, which may be subject to diverse policy influence
  - Infrastructure development, finance (risk allocation) and law may dominate engineering in much of the pipeline
  - The feasible technology portfolio may be limited with search space more diverse within a particular pipeline than between technologies in the portfolio
  - Industries with experience in R&D in particular pipelines more likely than governments to explore successfully this internal search space